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THE ART OF PRESERVING THE EYE-SIGHT.

Adapted from the French of ARTHUR CHEVALIER.

VII.—CONCERNING CATARACT, ASTHENOPY, AND ASTIGMATISM.

WE commence this chapter with a description of cataract. The word cataract is derived from the Greek *katarrhasso*, "I trouble," or from *katarrhaktes*, "waterfall." The best definition that has been given is that of Dr. Desmarres, who expresses himself in this wise, in his "Treatise on the Maladies of the Eyes:"

FIG. 51.
OPERATION FOR CATARACT BY EXTRACTION.

"Cataract is a partial or total opacity of the crystalline lens."

This affection was known by the ancients, and a description of it is found in the works of Celsus and Hippocrates; but they were greatly deceived as to its nature, for they believed that cataract was the result of a falling of liquid, which had the effect of dimming vision. This false idea was maintained in science until 1604, and it was only when Lapeyronie and Morand exhibited to the Academy of Sciences some opaque crystalline lenses that they had extracted, that the truth came to light. It is here that it is proper to recall the fact that every truth acquired is the work of several centuries, and that it is only by dint of perseverance and work that man succeeds in spelling the words in the book of nature.

What are the causes of cataract? Up to the present day all that has been said on this subject is pure hypothesis; it

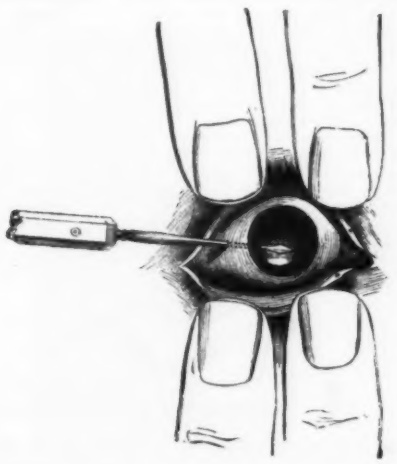


FIG. 52.
OPERATION FOR CATARACT BY DEPRESSION.

is proved, however, that old people are more predisposed to it than young.

Cataract, however, may exist at all ages, even in infancy. That it is hereditary is, at the present day, fully admitted. Maunoir has seen an entire family afflicted with this malady; all celebrated physicians relate similar facts. It has been said that robust people were more disposed to cataract than weak ones, but Dr Desmarres does not share this opinion, and temperament has nothing whatever to do with the cause of the disease. Women are as subject to it as men. As to professions nothing conclusive has as yet been established; and in spite of exact statistics it has been impossible to discover whether one calling has been more apt to give rise to it than another. However, it has been remarked, and rightly too, that blows, contusions, and punctures are a frequent cause of the disease, and it will be well, therefore, for every one to be on his guard. The progress of cataract is variable. With some persons the crystalline lens may become opaque in a few days, while with others it may take four, six or eight years to arrive at the same result. Occasionally an incipient cataract ceases to make any progress and remains always at the same stage. The symptoms which announce cataract have been very well described by Dr. Magne in his book on the maladies of the eyes; he expresses himself thus: "In general, when we are consulted in regard to eyes affected with cataract we find that for a longer or shorter time (months or years) the sight, which at first experienced a feeling of constraint, has become more and more difficult; a light mist or smokiness having interposed itself between the eye and exterior objects, and this cloud has ended in taking on the consistency of gauze, scarcely permitting the distinguishing of an entire object, and totally shutting out its details. Patients perceive in the majority of cases that they can see sideways better than forward, and in

FIG. 53.
SECTION OF EYE SHOWING THE POSITION OF THE LENS AFTER DEPRESSION.

twilight better than in a bright light, and that the flame of a candle ceases to appear as brilliant, but that it increases curiously in diameter, and seems to be surrounded by a halo. At the same time that the sight becomes dim, patients experience a sensation as if small bodies were placed before their eyes; and these supposed objects they sometimes compare to flies, sometimes to ribbon-like stripes, or, indeed, to hairs."

Cataract is a malady which is not often cured by medicines, an operation being necessary to remove the crystalline lens in order to render vision perfect. During the first symptoms something may yet be hoped from certain medicaments, but at the first warning an oculist should be promptly consulted. We may say here that the operation for cataract is not at all painful and requires but a few min-

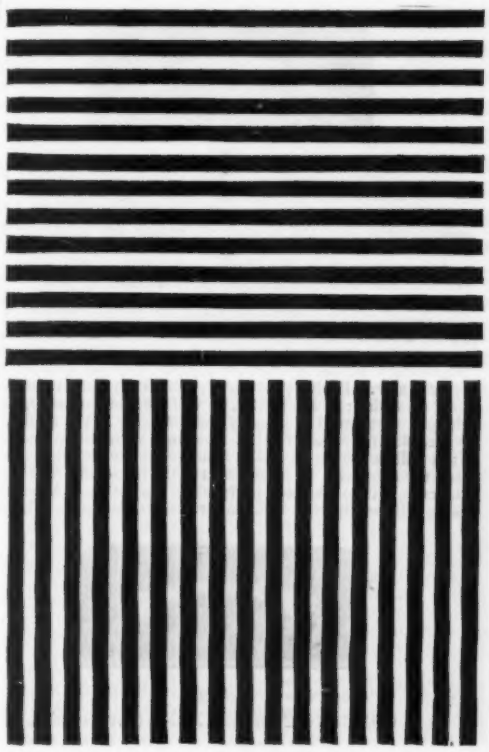


FIG. 54.
LINES FOR THE PURPOSE OF SHOWING THAT THE EYES OF EVERY ONE ARE MORE OR LESS ASTIGMATIC.

utes; out of twenty persons operated upon, nineteen succeed in seeing. The essential thing is to visit an oculist; and when we say that the success of the operation is almost certain, it will be only necessary to refer for proofs to the statistics of such celebrated doctors as Desmarres, Fano, Desormeaux, Sichel, Nelaton, etc. Cataract may proceed from an opacity of the crystalline lens (*lenticular cataract*), or to an opacity of the capsule (*capsular cataract*), or opacity of both lens and capsule (*capsulo-lenticular cataract*). Cataract of the *liquor morgagni* is, according to Dr. Desmarres, nothing but a softening of the crystalline lens to an extreme degree.

The diagnosis of cataract and the moment for operating on it belong to surgery. We will indicate (and that simply as a general observation) how the operation is performed. The surgeon chooses his method of operating according to the

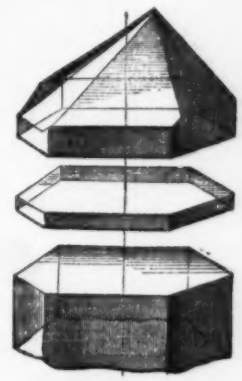


FIG. 55.
QUARTZ CRYSTAL, SHOWING METHOD OF CUTTING FOR LENSES.

kind of cataract he has to deal with. In the operation by extraction, an incision is made into the cornea with a flat, triangular knife called a *keratome* (Fig. 51), in such a way as to half detach it, but leaving a small point of attachment; this done, the crystalline capsule is cut into with the aid of a small special instrument called a *kistitome*, then the small point of attachment is cut, a light pressure is made on the eye, and the crystalline lens comes out without any difficulty. The fragments of the capsule are afterward removed and the operation is finished.

In the operation for depression of the lens, or "couching," a needle of special shape is introduced into the eye, near the cornea; the capsule is then cut, and the crystalline lens depressed and pushed into the vitreous humor, as shown in Fig. 52. The operation performed, it is necessary to supply

FIG. 56.

FIG. 57.
IMPERFECTIONS OF GLASS AS SEEN UNDER A LENS.

the need of a lens; and it is just here that the cunning of the artificer makes itself felt; it is here that we should bless Salvino Armato, that great benefactor of humanity, for it must be avowed that all the knowledge of our celebrated surgeons would be fruitless without the aid that optics lends us. Let us then bless Armato, for on the day that he invented spectacles he rendered the greatest service to the human race.

The operation for cataract was performed among the primitive Egyptians, under the reign of Ptolemy Soter. Galien, who lived under Marcus Aurelius, says that at Rome, in his time, there were specialists for this disease. Celsus has described the operation exactly; he made use of a straight needle. He says that, in operating, the needle should

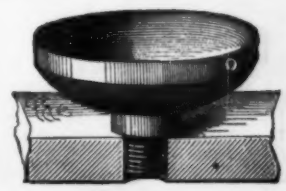


FIG. 58.
"CUP" USED IN LENS MAKING.

be plunged into the eye at an equal distance from the cornea and the external angle, and also that the opaque body should be drawn down under the pupil and fixed solidly at the base of the eyeball, and if it attempts to rise it should be broken up. It was not till the 18th century that the method of extraction was discovered; it is due to Richter, and was practiced for the first time by Wenzel the elder. It was he who operated at London, in 1763, on the Duke of Bedford; then, in 1771, at St. Petersburg, on the illustrious Euler, who discovered achromatism, of which we have before spoken.

Persons who have been operated upon for cataract should not allow themselves to use spectacles until seven or eight weeks after the operation; or, at least, not until all symptoms of congestion have disappeared. As soon as the doctor has withdrawn the eye from its obscurity, plain dark-colored glasses should be used; and these may gradually be replaced by others of lighter shade. At the end of a week or a fortnight the patient begins to distinguish objects pretty well; then, some time afterward (seven or eight weeks), vision begins to grow dim, and it is then that recourse must be had to

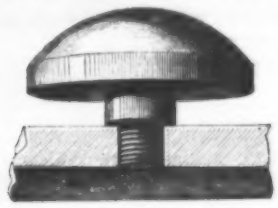


FIG. 59.
"BALL" USED IN LENS MAKING.

spectacles. The numbers used are generally those of the following foci: Nos. 2, 2½, 3½, 2¾, 3, 4, for reading; and 5, 5½, 6, for seeing at a distance. Often, after a time, it becomes necessary to take weaker glasses; and certain patients read with No. 5, and see at a distance with No. 6. The selection of the numbers in cases of cataract should be made with great care; and it is here again that we see the utility of a graduation by small degrees. Often, too, goggles with colored glasses are used if light is fatiguing.

Let us now speak of *Asthenopy* (called *Kopiopy* by Sichel, and known by the common name of "*weak sight*"). This is a very common and widespread affection, and often too little attention is paid to it. The word asthenopy signifies

FIG. 60.
MAKING LENSES WITH FIXED TOOL.

"eye without strength;" it is a particular state of vision in which near objects can at first be seen clearly; then, in a few moments, such fatigue supervenes that it is impossible to look any longer. Persons affected with this trouble experience no fatigue in regarding distant objects, and have perfectly healthy eyes.

The symptoms are these: When a person wishes to devote himself to work, say reading, writing, etc., he is obliged, on account of the fatigue that he experiences, and the dimness that seems to spread over objects, to quit such occupation at once; for if he persists, he feels a sense of weight in his

FIG. 61.
OPTICIAN'S LATHE.

head, his eyeballs pain him, and his forehead seems to be compressed. Women who are obliged to sew, dressmakers, florists, and those who write may often, after a rest over Sunday, work three or four days in the week; then it is impossible to continue it any longer. Persons thus afflicted are usually delicate. It is a common complaint of infancy and youth, and may last a whole lifetime. It may be congenital or acquired. In the former case it will be necessary to take the greatest precaution, for the patient is born with weak eyes; that is to say, with eyes whose retina tires very easily. This affection is often confounded with short sight; where it is acquired it is caused entirely by a forced application of the sight on small objects; and hence we should not be surprised to find so many serving women, tailors, watchmakers, designers, compositors, frequently afflicted with it. It is a grave affection, which appears to be seated in the retina; and the greatest attention should be paid to it. If it is caused by one's profession, this would be better changed, otherwise there will be little chance of a cure. The treatment of asthenopy is in avoiding a use of the eyes on small

FIG. 62.
DOUBLE CONVEX LENS (Isosceles).

objects, or at least in resting them quite frequently, and often in abstaining from work altogether for a period of several weeks. Sea baths, cold water baths, and a host of remedies that do not come within the scope of this work, have all been recommended. But there is one thing that *is* necessary—an oculist should be consulted.

Convex glasses are proper in asthenopy, and they often allow the patient to continue his occupation. In case they are used, Nos. 90, 80 and 72 will be found to give the greatest relief. It will be necessary in these things to use the greatest circumspection and to have dealings with an able practitioner only.

Amblyopy is an affection entirely different from asthenopy. In the former, near or far objects are obscure, and

FIG. 63.
DOUBLE CONCAVE LENS (Isosceles).

if a person afflicted with it fixes his eyes firmly on them he may succeed in seeing slightly; while, in asthenopy, it is in gazing fixedly that causes confusion. Amblyopy is a grave affection that needs the prompt intervention of a physician. The use of convex glasses does not appear to be useful; however, they may be tried, for in certain cases of *Asthenopic Amblyopy* they may (as Dr. Desmarres remarks) possibly lead to good results. Let us not forget that among the numerous causes of this trouble may be cited as a prominent one the use of glasses that are too strong, as well as of those that are too weak. This should prove a warning. If amblyopy be not promptly attended to, it may run rapidly into *Amaurosis*, that is, loss of sight; and, in the latter case, our celebrated physicians have great trouble in extirpating the evil. However, there should be no dis-

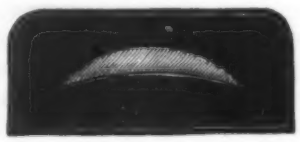


FIG. 64.
MENISCUS LENS (Periscopic).

couragement, for the science of optics has immense resources and celebrated representatives.

Astigmatism from the Greek *a*, privative, and *stigma*, a *point*, arises from an inequality of refractive powers between the different meridians of the crystalline lens. Thanks to the learned researches of Messrs. Donders & Javal, we know to-day just what this affection is, and how to study it in all its details. A meridian of the eye is the intersection of the eyeball by a plane passing through the optical axis. If this plane is vertical it is called the vertical meridian; if horizontal, it will be the horizontal meridian. Astigmatism is easily understood. Let us suppose a horizontal meridian, having a normal refraction, then images will be pictured on the retina. Let us suppose, again, that the refraction be stronger in the vertical meridian, then the rays will be pictured in front of the retina. After that there will be dimness and confirmed astigmatism. Every-

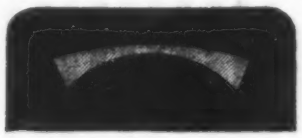


FIG. 65.
CONCAVO-CONVEX LENS (Periscopic).

body possesses astigmatism, called for this reason "normal astigmatism;" but the differences of refraction being feeble, the clearness of images is not affected. It was Young who first called attention to this anomaly; and afterward, Airy, the celebrated English astronomer. The accompanying plate (Fig. 54) will serve to show that we are all astigmatic in a slight degree; for if the figure be held close to the eyes, the horizontal lines will usually be seen with greater distinctness than the vertical. This trouble depends on a want of symmetry in the cornea. It may depend also on a defective conformation of the lens, the meridians of which, in this case, are unlike as to refraction. There are different kinds of astigmatism, which it would scarcely be necessary to enumerate in this place. Cylindrical glasses are used to correct the affection.

Asymmetropy is an affection in which the eyes have unlike foci while possessing the same species of sight, or, again, while possessing vision of a different nature. Thus, for instance, we meet with eyes that are unequally long sighted or short sighted; at another time we may meet with a case where one eye is long and the other short sighted. When the difference is very great there is no fatigue; a single eye does the work, and the patient is often never aware of it; but when small differences exist there is usually ocular fatigue, and the anomaly should be seriously examined. Glasses of different foci are used, but it should be stated that, while concordance may be established in presbyopy, it never can be in myopy. In the first case the differences are

FIG. 66.
ACHROMATIC LENS.

always small. Thus a long-sighted person may be able to wear on one side No. 18 and on the other No. 20. In myopy the differences are more marked, and when a trial is made for each eye with the glasses chosen one eye will always see better than the other. In the majority of cases glasses should be discarded, for they will cause fatigue.

In cases where one eye is long and the other short sighted we may, if the affection is but slight, find glasses with foci that may serve to establish perfect vision in both. It is only necessary to consult a scientific optician to have such matters attended to satisfactorily. As regards eyes that are unlike, we will mention a fact that is met with every day: A great many persons are born with one eye weaker than the other, and the most *singular thing is that they seldom, if ever, know it.*

VIII.—SPECTACLES, AND HOW THEY ARE MADE.

The word "spectacles" is derived from the Latin *spectare*, "to look at." These important aids to imperfect vision were unknown to the ancients, whose lenses were, according to Seneca, globes of glass filled with water. In those times, therefore, people who had enfeebled vision were obliged, so to speak, "to go blind." Cicero, Nepos, and Suetonius say, in regard to this, that when eyesight became weak the persons afflicted had their reading done for them by servants.

After a thorough search through old manuscripts we are obliged to accord the palm to Salvino Armato as the in-

FIG. 67.
ACHROMATIC LENS.

ventor of spectacles. Armato was a Florentine nobleman, who lived about the year 1300; before him we find no trace of any such invention. His tomb still exists at Florence; and underneath his bust, carved in a large marble slab, may be read the following inscription:

"*Here lies Salvino Armato d'Armati, of Florence, inventor of spectacles. May God pardon his sins. A. D.* 1317."

Of the Glass used for Spectacles.—As is well known, glass is a true salt; it is a basic silicate of potassa, lime and soda, and alumina, to which, in optics, the name of *crown glass* is given. If lead be added so as to make a silicate of potassa and lead, glass thus formed is called *flint glass* in optics, and *crystal* in common parlance. In this chapter we will examine separately the different glasses used in optics, which are: (1) crown glass, (2) flint glass, (3) rock crystal.

(1.) *Crown Glass* is a silicate of soda and potassa; no lead enters into its composition; it is harder than flint glass, and is used for our mirrors, window glass, and drinking vessels. The beautiful Bohemian glass is also of this composition; and although it lacks the brilliancy and sonorousness of flint glass, yet it is much harder. The characteristic of sonorousness may serve as a test to distinguish flint from crown glass. Crown glass is very much used in optics; employed alone, it serves for magnifying glasses and various other lenses; and in conjunction with flint, it forms achromatic glasses. There are two kinds of crown glass, "commercial" and "pure." The first is of a greenish tinge, and streaky, and is used principally for windows, cheap mirrors, etc. The

FIG. 68.
BICYLINDRICAL LENS.

other is colorless, limpid, and free from defects, and is the ne plus ultra for spectacles, and those made from any other kind or quality of glass should be rejected.

(2.) *Flint Glass.*—The origin of flint or crystal glass is very ancient. The estimation in which this article is held is due to the English. At the present day it is in universal use for making fine table glass, etc., although the glass for this purpose is less rich in lead than that employed in optics. As we have before stated, flint glass is used in the fabrication of achromatic lenses, since it possesses great dispersive power; that is, it decomposes light to an extreme degree, and consequently sparkles, thus peculiarly fitting it for such objects as chandelier pendants, etc. It is, however, the most detestable substance that can be used for spectacle glasses; for in decomposing the light it becomes iridescent, and thus injures the sight. Another trouble is that, on account of its soft nature, its surface is easily scratched.

(3.) *Rock Crystal.*—Rock crystal, or quartz ("pebbles" of the English), is often used for making spectacle lenses. When properly cut it is only *half* good at best, for it general-

ly injures the vision. Transparent quartz is a widely disseminated mineral; its primitive form is that of a slightly obtuse rhomboid. Its specific gravity is 2·04, and its fracture vitreous. It gives forth a spark when struck with a piece of steel. Its composition is, silicon, 48·5; oxygen, 51·95. It is invested with the property of double refraction, which renders it unfit for use in optics, and particularly for making spectacle lenses; for if images do not appear double through such lenses because of their thinness, it is none the less true that double refraction exists, and that it may occasion considerable visual trouble. However, by suitably cutting it, double refraction may in part be avoided. For this purpose every part to be used for spectacles should be cut perpendicularly to the axis of the crystal, as represented in Fig. 55, where are figured the axis and the line perpendicular to it. This applies to crystalline forms of the mineral only; for where it is in an amorphous mass, double refraction cannot be avoided in cutting the lenses. There is a very widespread error relative to rock crystal. This mineral being more refractive than crown glass, it is necessary, in order to obtain a given focus, to give less curve to the lenses than those possess that are made of crown glass. So, to obtain No. 18, it is necessary to give curves of 18¼ to rock crystal. It happens, then, that almost every one who wears "pebbles" has a *number stronger than the one suited to him.* If what we have remarked has been attentively read, it will be seen that we believe that (1) *pure crown glass is the only kind capable of being used for spectacles;* (2) *that flint glass should be entirely rejected;* and that (3) *rock crystal, no matter how it is cut, should be rejected likewise.*

The Manufacture of Optical Glasses.—Before working, the glass is carefully selected, every portion being examined with a magnifying glass. If bubbles (Fig. 56) or striæ (Fig. 57) are detected, it is rejected, at least by conscientious opticians. Air bubbles cannot always be avoided in making

FIG. 69.
PRISMATIC LENS.

large lenses, but they should not exist in small ones—especially in those for spectacles. However, a small bubble would prove less injurious than the striæ or threads, which proceed from an imperfect mixture of the vitrifiable matters. There may exist, also, flaws having the appearance of snowflakes, and earthy or metallic specks, spots of different form, etc. It is only when the glass is free from all such defects that the optician judges it fit to be worked up. Glasses designed for telescopes come from the glass works under the form of disks of various diameters and thicknesses. Polished facets are made on the sides of the disks so that the quality of the glass may be examined. Disks are also made for small lenses, but very often they are sawed into plates, which are afterward cut into the appropriate sizes. The curves of the lenses are obtained by grinding the disks with moistened emery spread over the surface of copper cups. The tool represented in Fig. 58 is called the "basin," that in Fig. 59 the "ball." It will be at once understood that the "basin" serves for making convex lenses, and the "ball" for concave lenses. Each tool represents a degree of curvature. In the workshops of opticians there are always kept three or four hundred pairs of tools, having curves from twenty feet to the one-fifth of a line. The tools are usually numbered in inches and lines; sometimes in divisions of the meter. Curves are always calculated by the aid of mathematics. The tool, furnished with a screw stem, is fixed in the lathe of the optician either in a stationary nut or on a block which may move in a circular direction. Circular work, with the tool fixed (Fig. 60), is used for glasses of a certain diameter. For small lenses the simple lathe is employed (Fig. 61). The emery used is of different degrees of fineness.

Without entering into technical details, we may say that the glass being fixed on a cork "muller," its surface is polished with finer and finer emery, until it has a fine grain.

FIG. 70.
THEORY OF VISION THROUGH THE PRISM.

Paper is now glued to the tool, and fine tripoli powder strewn over it; and the glass being afterward rotated in contact with this material, ends by taking that fine polish that is known to every one. Very small lenses are polished on pitch polishers glued to the tool, and with the aid of moistened tin putty. This same method may be used for large lenses, but great care must be taken in the manipulation. Usually, good glasses are made separately, and with such precautions as we have just indicated. As regards spectacle glasses, let us specify further that they should be well centered, of equal thickness, finished one by one, being polished with tripoli and tin putty.

Ordinary lenses for spectacles are made of the same kind of glass as that used for windows—impure crown. They are also made in quantities at a time. Fifty or sixty bits are glued to either the basin or ball; then the polishing material being placed on the opposite tool, the tool covered with the glasses is rubbed around the latter, either by hand or by machinery. This method is a very bad one, for the lenses placed near the circumference of the tool do not obtain regular curvatures, and their polish is not uniform. All the glasses made in this way are polished with thick cloths covered with rouge; 5,000 pairs are turned out every day in a locality not far from Paris.

The Shapes given to Spectacle Glasses.—We distinguish two kinds of glasses in general use—the *isosceles* and *periscopic* Lenses called isosceles have, as their name indicates, equal curvatures (Figs. 62 and 63); those named periscopic (from the Greek *peri*, around, and *skopein*, to see) have their curvatures unequal. Of the latter, the convex lens (Fig. 64) presents the strongest curvature on the exterior, while it is the contrary in the concave lens (Fig. 65.) The lenses most generally used are the isosceles; from an optical standpoint, however, they are not the best, and generally—except in certain special cases—periscopic glasses are of more value. In a general way, we may say that periscopic glasses are preferable to all others for presbyopy, reading, writing, and for distant objects. For myopy it is the same, and if it happen that a myope or presbyope finds that isosceles glasses suit him better, it is because he is already used to this kind; in such a case it will be difficult to make him use others.

Wollaston popularized periscopic lenses; but they were known before his time, and the great philosopher, Descartes, who lived in 1650, figured them in his "Dioptrics."

Spectacle glasses, really achromatic, were first made in 1841. In Figs. 66 and 67 are represented convex and concave lenses of this kind. Other forms than those already cited are given to spectacle glasses. Thus plano-convex and plano-concave lenses, or spherical ones with unequal curvatures, are made with a mistaken idea. These should all be rejected, for they are affected with aberration to an extreme degree.

Plain colorless glasses serve in certain cases to shield the eyes from wind and foreign bodies; if they are not parallel, they *double the luminous points;* this, then, becomes a means of verifying them. In holding them at a short distance from the eyes and in turning them around they should not appear to make objects move. *Bicylindrical concave* or *convex glasses with crossed axes* (Fig. 68) are pernicious for myopy or presbyopy, *except in case of astigmatism.* Fig. 69 represents a *prismatic glass;* this form is used in double vision (*diplopy*). It is well known that prisms have the property of separating the luminous rays at their base, as shown in Fig. 70, which explains the deviations of vision by the aid of prisms.

In conclusion, we will indicate the method in use for finding the foci of lenses. Everybody knows that if a convex glass of given focus be placed on a concave one of the same focus, objects are thereby neither enlarged nor diminished; then, given a convex or concave lens whose number is unknown, a lens is sought which, placed in juxtaposition, shall produce the above effect. As the lenses used for the test are numbered, there is nothing left but to read the focus thus determined. The focal distance of convex lenses might be determined by means of the sun; but the method would be difficult for concave lenses.

ANTIDOTE TO MERCURY AND LEAD.

A PRIZE of $2,000, founded in Belgium by Dr. Guinard, to reward any discovery tending materially to improve the material or intellectual condition of the working classes, has, by the jury, been unanimously awarded to M. Melsens, a member of the Belgian Academy. M. Melsens has discovered a method to counteract the poisonous effects produced either by emanations or by absorption of poisonous metals, or rather, to prevent their deleterious effects. The agent he employs is iodide of potassium. Affections of this kind depend on the presence in the organs which are the seat of the malady of insoluble metallic compounds; iodide of potassium converts them into soluble metallic compounds, and expels them. For a long time iodide of potassium has been considered as a true poison. M. Melsens began by proving that the drug is inoffensive, on the essential condition of its being perfectly pure, and being administered in doses at first small, and gradually increasing. The administration of very strong doses to persons poisoned would produce in the system a quantity of double soluble salt, sufficiently large when drawn into the circulation to cause real ordinary poisoning. The insoluble compounds of mercury, as well as those of lead, are easily transformed into soluble compounds by means of the alkaline iodides, and these soluble bodies are eliminated by the secretions of the body. The sulphate of lead, which is but little soluble in water, is, however, a poison fatal to animals, and it is as dangerous to handle as the carbonate of lead and all the other insoluble compounds of this metal. All these bodies are eliminated by the action of iodide of potassium, which frees the system of them and prevents their deposit in the organs, when administered in suitable doses. M. Melsens has obtained a Montyon prize from the French Institute for the same discovery.—*London Times.*

FLOWERS OF SULPHUR IN SCIATICA.

WE learn from *Les Mondes* that M. Henry G. de Mussy has called the attention of the Therapeutical Society to a treatment employed in England, and which, in one case, led to unexpected results. The process consists in dusting with flowers of sulphur the course of the sciatic nerve attacked with the neuralgia, called by its name *sciatica*, making a friction and wrapping the limb in flannel. M. de Mussy has had occasion to try it in the case of a person who had been suffering for three years with an extremely painful attack of sciatica. Twenty-four hours after the application of the treatment the pains had completely disappeared. This treatment has been described by several English physicians. It is difficult to explain to what these happy results are due; but an important fact to be noted is that, after this application of sulphur, a considerable quantity of the latter is found in the urine of the patient.

M. Bucquoy states that he has under his care a patient who has the most unlimited confidence in the method of treatment indicated by M. de Mussy, and who, as soon as the pains of sciatica make their appearance, at once places flowers of sulphur either on the lumbar region or under the sole of the foot which corresponds to the afflicted side. In every case the pains disappear almost immediately.

May not the success of this treatment be due rather to absorption than to a local action? If so, we will be face to face with a classic treatment of rheumatic affections—the use of sulphurous medicines.

SALE OF THE LIBRARY OF THE LATE FIRMIN-DIDOT.

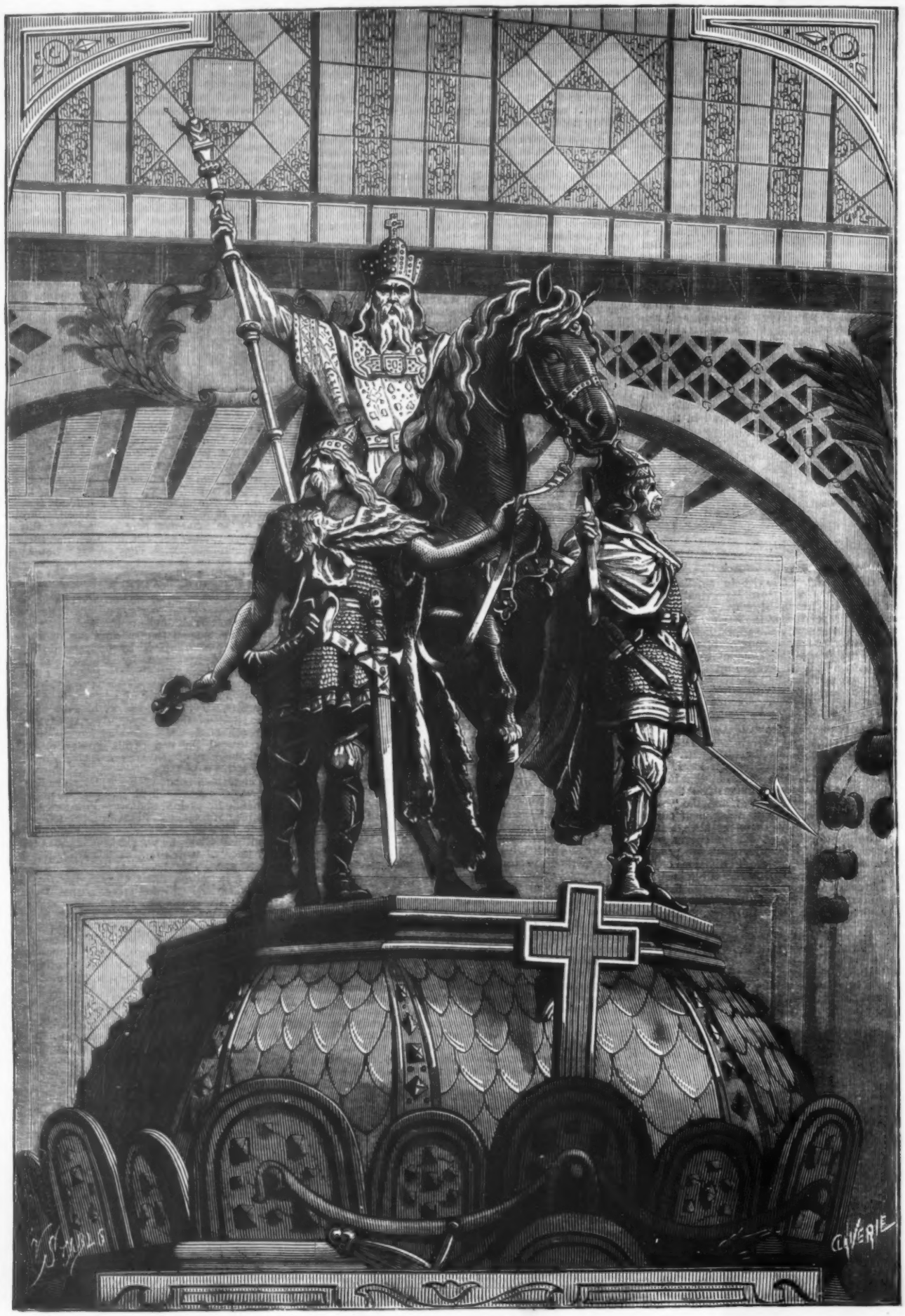
THE bibliophiles of Paris are plucky fellows in the auction room. The splendid library of the late Ambrose Firmin-Didot was sold in June last, the sale lasting from the 6th till the 15th, and some of the treasures fetched prices that recall the famous sales in London sixty or seventy years ago, when Dr. Dibdin was sowing broadcast the ineradicable seeds of book-madness in his Bibliomania and Bibliographical Decameron. The choicest books and manuscripts were struck off to native bidders, notwithstanding the prowess of Quaritch and Ellis, of London, Cohn, of Berlin, and other foreign booksellers. The Didot library was the finest private collection in Paris, being remarkably rich in early French poetry, both in manuscript and print, and containing many rare early printed books. Many of the early poems and ballads in manuscript possess a high value for the light they throw upon the formation and growth of the French tongue, and the Société pour l'Impression d'Anciens Textes Français, corresponding to the Early English Text Society, was a liberal purchaser in this department. Some of the prices obtained at the sale are worth quoting: A copy of "Le Chevalier aux Dames," a small quarto printed at Mentz in 1516, and intended as a defense of the ladies against the calumnies of the "Roman de la Rose," sold for $2,220, though at the Yemeniz sale in 1867 this identical copy went for only $415. A sixteenth century manuscript, "La Coche, ou le Débat de l'Amour de Marguerite d'Angoulême," brought $4,000. "Le Trespas de l'Hermine Regrettée," an unpublished vellum manuscript, executed about 1515, and enriched with five miniatures, went for $2,620. A Latin-French dictionary, in manuscript, dated 1440, was bought by M. Champion, the representative of the Text Society, for $1,800.

There was a spirited contest over "Les Chroniques des Anciens Rois et Ducs de Bourgogne," and it was knocked down for $4,125. The treasure of the collection was the "Chronique de Normandie," a beautiful manuscript of the fifteenth century, splendidly illuminated, and containing fifteen fine miniatures. Here again was a contest, but one which narrowed rapidly as the bidding rose into the thousands. It fell to Morgand & Fatout, whose stock is well known to amateurs here by their monthly catalogues, for the great price of $10,200. Mr. Quaritch succeeded in getting a choice manuscript copy of the "Roman de la Rose" for $1,920, which is almost exactly the price paid for another copy of this celebrated *Roman* by a New York collector in London ten years ago. The American had a formidable competitor in the agent of Napoleon III., who had orders to buy the manuscript at any price. The agent lost track of the sale, however, through a fire and postponement, and the American secured the treasure for a little over $1,900. It had been a little injured by the fire, and the purchaser had it sumptuously rebound by Bedford. This copy was on vellum, and was probably the work of a fourteenth-century scribe. His work evinced his taste and skill, for the illuminations and miniatures, of which there are thirty-eight, are exquisite. The colors are as brilliant to-day as when they were applied 500 years ago. Charles IX. once owned it, that monarch of dreadful memory having cultivated polite letters toward the end of his short life. It was sold at the auction rooms of the Messrs. Leavitt, in this city, in January last, for $1,160.

The printed books of the Didot collection brought prices almost as remarkable as those of the manuscripts. Baron James de Rothschild appeared as the purchaser of "Olivier de Castille," a romance of chivalry, printed probably at Geneva about 1490, and containing but 53 leaves, for $4,000, or about 100 times its weight in gold; also, of "Lestrif de la Fortune," of which only one other copy is known to exist, for $4,080. This book was printed by Colard Manson, of Bruges, in whose office Caxton, the first English printer, learned his art. At the Yemeniz sale, 1867, it brought but $1,400. The baron also bought the unique vellum copy of "Cleviadus et Meliadice," Paris, 1495, for $3,300. Several early editions of Corneille were sold for prices that would fill him with amazement could he return to enjoy such posthumous compliments. Over $1,000 was paid for the three-volume edition of 1644-52. The 1664-6 edition, in six volumes, brought $2,880. A copy of the "Chroniques de Monstrelet," from the press of Anthony Verard, about 1500, sold for $6,100. By the way of addenda to the quotations it may be stated that a vellum copy of the famous Mazarin Bible, from the press of John Gutenburg, Mentz, 1455, the first book ever printed, was sold in Paris, June 1, for $10,000. A copy brought $17,000 in 1873, while Brunet records the sale of a copy sixty years ago for $240, and Count MacCarthy's sold for $1,252.

Such prices as were paid at the Didot sale are not to be obtained in New York. They are no longer possible in London, where bibliomania reached its climax at the great sale of the Duke of Roxburghe's library, in 1812. What book-hunter has not read Dibdin's turgid account of the tremendous struggle at that sale for the Valdarfer "Boccaccio" of 1471, the *editio princeps*, between Earl Spencer and the Marquis of Blandford, when the bids jumped £50 at a time, until the hammer fell in the Marquis' favor at $11,300? It is no longer the occupation of noble English lords or rich gentlemen to collect "large paper," "uncut" or "tall" copies; nor are there "bibliotaphs," like Heber, whose unlimited means enabled him to bear down all opposition in the auction room, and to collect vast libraries, or rather heaps of books, in London, Paris, Louvain, Cologne, and other cities. It is related of him that he once begged the loan of a book of which he knew he possessed six copies, but was unable at the moment to lay his hand on any one of them.

In this country great wealth is rarely joined with a taste for books. Our collectors are mostly men whose limited means compel them to curb their passion severely, and some no longer trust themselves in the auction room or book-stall. A few years ago the mansion of an old and wealthy family—whose name, indeed, is a synonym of opulence in New York—was about to be torn down to make room for a business block. The massive and costly bookcases were removed, and were found to be filled with "dummies," blocks of wood dressed up like elegantly-bound books. Fancy the withering contempt that such a disgraceful exposure would have evoked from old "Fogy" Dibdin, or Richard de Bury, or Isaac Disraeli, or so famous a book-collector and book-reader as Sir Walter Scott. While our rich men continue to be indifferent to matters of title-page and colophon, and still more deeply ignorant of the contents of books, and the only purchasers in the market are, as now, men of slender fortunes, the book trade here will not recover from a "languid and depressed state," even worse than that which called out a once famous letter to Richard Heber, entitled "Bibliophobia."—*N. Y. Tribune.*



THE STATUE OF CHARLEMAGNE, AT THE PARIS EXHIBITION.

THE STATUE OF CHARLEMAGNE.

The late M. Rochet, a born Parisian, pupil of David d'Angers, sent to the Exhibition of 1867 a plaster cast of an equestrian statue of Charlemagne. This work has now been cast in bronze by M. Thiébaut, and is displayed in the present Exhibition. The artist is represented by two other works —Cassandra, pursued by Ajax, taking refuge at the altar of Minerva, a bronze group, with gold and silver in parts, which was first submitted to criticism in the *Salon* of 1870; and the infant Bacchus, being borne by Mercury to the nymphs, who were charged with his education. This striking group, in bronze, was exhibited in the *Salon* of 1876. The statue of Charlemagne, which is figured in the above illustration, is the grandest of the master's three works. The eternal struggle between French and Germans has invaded the sphere of history, and while the French claim Charlemagne as a national hero, he is asserted to have been exclusively a German by others.

"No claim," says an English writer, who is more German in his sympathies than the Germans themselves, "could be more groundless than that which the modern French, the sons of the Latinized Kelt, set up to the Teutonic Charles. At Rome he might assume the chlamys and the sandals, but at the head of his Frankish host he strictly adhered to the customs of his country, and was beloved by his people as the very ideal of their own character and habits. Of strength and stature almost superhuman, in swimming and hunting unsurpassed, steadfast and terrible in fight, to his friends gentle and condescending—he was a Roman, much less a Gaul, in nothing but his culture and his schemes of government, otherwise a Teuton."

We must say that when Dr. Bryce thus takes everything manly and great and classes it as therefore German, and then deduces, from the possession of great and manly qualities, the conclusion that Charlemagne was a German, he argues in a vicious circle. If Charles ruled at Aix-la-Chapelle and Engilenheim, he ruled also at Paris; if his army was Frankish, modern "French" is but old Frankish, "writ short." His great triumph was at Rome, the city over which the French Emperor within our own time still exercised a protectorate. His famous defeat, about which many fables cling, was at Roncesvalles, between France and Spain, distant indeed from the borders of Germany. M. Rochet's sculpture shows him in the character of predecessor of the Most Christian Kings of France, his crown ornamented with the cross, holding a scepter in his hand, accompanied by a spearman and a hatchetman, members of the hardy host which warred down the Saxons. The group decorates the top of one of the lofty trophies in the Exhibition building.—*Illustrated Paris Universal Exhibition.*

ENGLISH INDUSTRIES AND AMERICAN COMPETITION.

I.

THE present depression which exists in nearly all the industries of this country, although not more severe than on some, or even many, former occasions, has nevertheless awakened more interest among all classes than ever before, and reasons for this are not wanting.

In former cases the causes of depression have generally been traceable to circumstances of a more or less transitory kind, such as fluctuation of prices, disturbance in markets, commercial failures, and so on, but at the present for the first time American competition is realized and admitted as affecting several branches of English manufacturing industry. Such competition has heretofore, except by a very few, been treated as a myth, and disposed of by what we will call economic speculation, or economic conclusions drawn from statistics, and by a reiteration of the supremacy of native skill; but now it is evident some new mode of treatment must be adopted if we are to compete with the rapid changes and innovations which the restless inhabitants of the New World bring to bear upon all they undertake.

Competition with European countries possessing fewer natural resources than our own, and having no advantage to speak of in climate, food, fuel, intelligence, or physical power, is a matter which can be very safely measured in a statistical way; but in the case of a people speaking the same language, in possession of the same scientific data, with a physical and moral power equal to our own, more active in their habits, and at the same time with greater natural resources, statistical conclusions are too slow; they apply after the circumstances on which they were founded have passed away.

The elements, as they may be called, which go to make up the producing power of a country's industries are composed of two kinds or classes. One consists of various factors which are constant or nearly so, non-progressive and beyond control; among these are climate, material, fuel, food, and other resources generally spoken of as natural. The other class of factors is such as can be created, changed, or improved, consisting of machinery and implements, processes, skilled labor and its control, and it is to these latter especially that attention will be called in the present case. There are, it is true, various other things essential to the successful conduct of modern industry which might be named as factors; capital, commercial connections, and prestige are among such, but these, like implements and skill, are amenable to human effort, and are by no means to be relied upon as permanent advantages reaching beyond a period wherewith we have present concern.

Thus far, as previously remarked, comparisons between our own and American skilled industry have been for the most part founded on statistics, supplemented it is true in many cases by observations made by travelers and the opinions of many who have investigated special cases, and it might be said nothing more can well be expected; yet it is believed that a general review at this time of the particular modes of conducting American skilled industry, especially in such features as differ from our own methods, will be of both interest and advantage to many of our readers.

It is but fair, however, to remind them, both here and in America, that general conclusions often fail to apply to particular cases, and that personal opinions are as a rule based upon such cases, so that in a country as large as America, and where industries are, like the climate and people, extremely diversified, it will be very difficult to speak in general terms even of a particular branch of industry.

That there is much in American practice which older countries can adopt with advantage, no one who is acquainted with the subject will deny, and obviously we, with colonies to supply whose wants are analogous to those of America, should not be backward in taking lessons when circumstances permit.

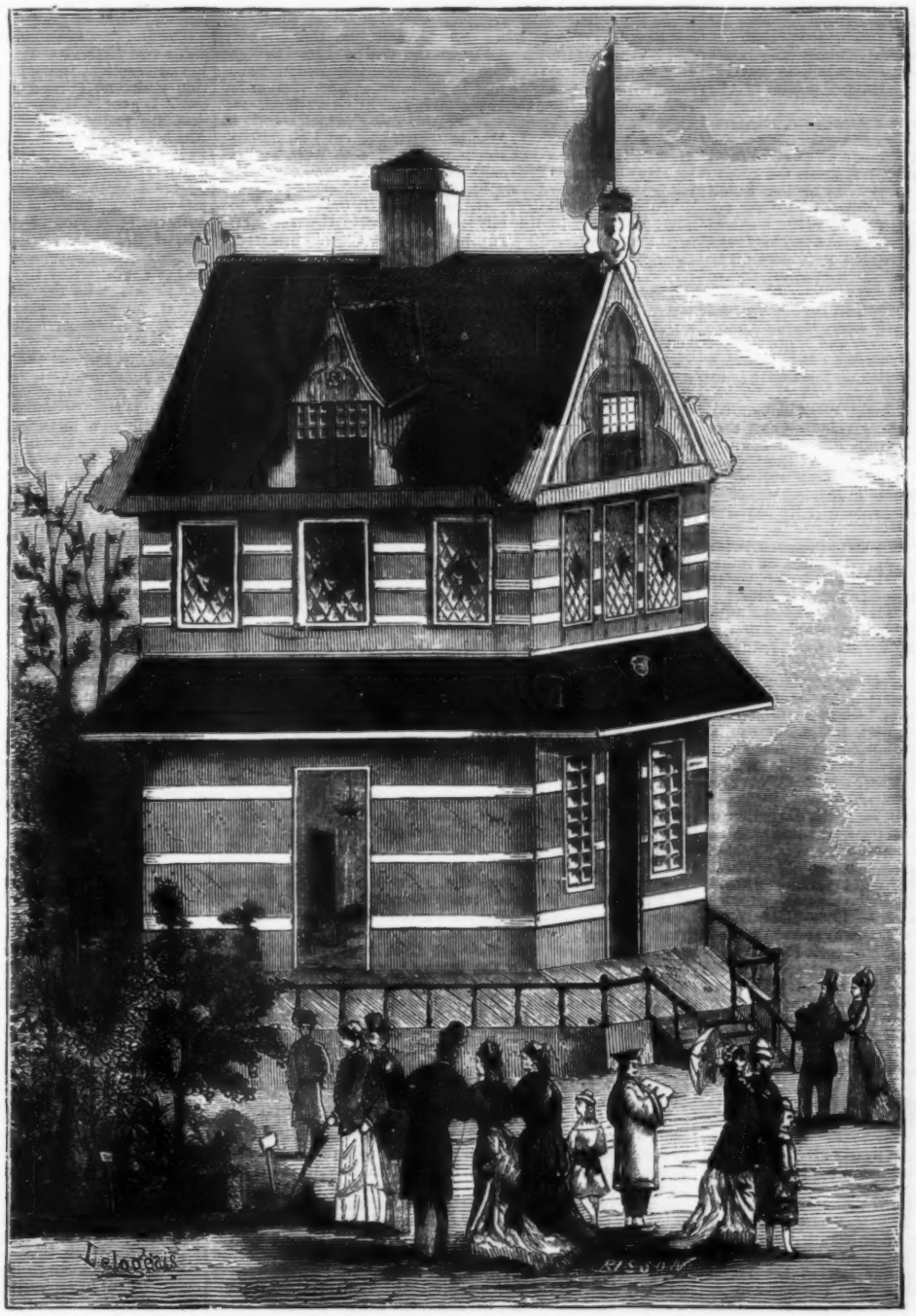
No nation in Europe has so much intercourse with America as ourselves, and every circumstance points to a more extended intercourse when the existing trade restrictions in America are removed or modified. The language and literature, including technical learning of all kinds, as before remarked, may be said to be in common, yet with all this it is questionable if we derive as much advantage from American improvements as some other European countries.

It is true that most inventions and discoveries find their way from America to England nearly as soon as made, but they are in almost every case brought here by Americans, who by persistent effort succeed in having their inventions adopted; perhaps no fault should be found with this latter fact when we consider the many foolish and impractical things which have their origin there, but certainly with our alleged superiority of scientific discernment we should be able to select what is good and adopt it soon enough to have a fair start.

In these remarks we have in view certain industries which will be more fully noticed in future places, and are not speaking of the spirit in general with which improvements and changes are met in this country; but interests are certainly in many cases sacrificed to prejudices, and a great difficulty in meeting and combating American competition exists in slowness and conservatism.

It is true our main disadvantage at this time rests in causes less easily controlled than conservation, or an aversion to sudden changes, that is, in labor disturbance; and it may be added that to this branch of American industry, the control of skilled labor, but little or no attention has been given.

The discussion of the subject of skilled labor, and the various conditions which attend on it, naturally leads into the field of moral and social problems which lie outside the usual scope of engineering journals; but it is the readers of such journals who mainly have to contend with and remedy the evils of labor disturbance, so that, after all, problems of the kind are in some sense a practical detail of manufactures which sooner or later must have some other treatment than the application of economic theories, at least by those who have no practical knowledge of much that concerns skill and its proper control.



DUTCH WORKMEN'S DWELLING.—AT THE PARIS EXHIBITION.

CO-OPERATION IN AMERICA.

One of the most marked among characteristics of American skilled industry, and one which we think deserves especial attention in this country, is what may be called co-operation between different manufacturers in the same line, and a general co-operation throughout the whole industrial interest.

In Europe the term co-operation when used conveys an idea of combination, an alliance of interests to gain force or advantages which different firms or companies could not enjoy while acting independently; but this is not the meaning intended to be conveyed in applying the term to Ameri-

can industry. Combinations there are not popular, and are seldom successful when not bound together by stronger considerations than to control commercial markets or prices. The whole tendency is to the individuality of firms or companies, and by co-operation is meant a friendly intercourse which spreads common knowledge of any art, and leads to that versatility of knowledge on the part of Americans which has been the wonder of other countries.

The idea of works, no matter of what kind, being founded and conducted on inventions and improvements made within itself, and independent of common progress or common knowledge of the business carried on, is scarcely to be found in America. Every business, it is true, may have some peculiar features, but such features are few, and they soon pass into and assimilate with the stock of common knowledge. Trade secrets are generally derided, and so indeed is the idea of controlling any trade by processes kept secret. Such a spirit is generally characterized as selfish and mean.

As a rule, each prominent manufacturer in any line is personally acquainted with every other prominent manufacturer in the same line; friendly visits are interchanged, and not to be invited to "go over the works and see the improvements" would be considered a grave discourtesy. The relative merits of new inventions are discussed, and every one takes a pleasure in pointing out in friendly emulation how *his* plans are better, and the products of his works superior.

Now this may not be a rule applicable in every case, but it is a general custom, and leads to results which in the end will have much to do with the producing power of the country.

It is no uncommon thing to hear two American engineers, for example, in talking together, discuss consecutively the circumstances of any or every establishment of any size from Maine to California, and for either to not know the name, history and class of every firm or company in his line would be thought stupid. This is the more remarkable when the vast size of the country is considered, as well as the suddenness with which changes are made, and it is a matter traceable to a variety of causes, some of which it is difficult to understand in Europe, where similar circumstances do not exist.

In the first place, the value placed upon inventions and special knowledge is very little. Nearly every machine, tool, or process is understood to be temporary, and soon to pass away, and the object is not to preserve what exists so much as to be first in reaching improved substitutes for implements or new methods for processes.

Another reason for the common diffusion of skilled knowledge is that however much Americans value money, they generally make gain subservient to pride, and in a country where industry and material improvements hold the highest place among callings, and where the social scale rests on a wholly different basis from what it does in Europe, the pride of technical knowledge far exceeds what will be found in older countries.

The effects arising from this friendly co-operation between manufacturers are vast and important. Perhaps no other single cause has contributed more to that wonderful success which has attended so many branches of industry in America, and this effect will be greater still if this spirit of co-operation should assume the nature of a national trade combination, as it has already threatened to do in some instances, that of paper manufacture for example.

It is however questionable whether trade combination for commercial purposes will ever become popular or even tolerable in America. As before said, the idea is an unpopular one if not founded on skill or invention instead of capital and commercial schemes. Among the commercial community, and independent of manufacturers, the matter is different, but skill, we venture to think, will scarcely ever be bound in such leagues.

One marked effect of co-operation is in the education of labor and the versatility of knowledge produced among workmen. They are emulative the same as their employers, and as no small share—perhaps the greater share—of improvements in tools, machines, and processes come from workmen, we can well imagine the effect of common knowledge when contrasted with special knowledge. To illustrate this one may inquire of almost any fitter in a railway shop in respect to the capacity and merits of the machine tools made by different firms, lathes for turning axles as an example, and the result would be that such a fitter will be able to tell the number of axles turned in a given time on different kinds of lathes in different parts of the country, also the price of lathes by different makers, their peculiar features, and will perhaps wind up with a remark to show that he himself has done or hopes to do as many in a day as ever had been fitted by any person.

Competitive tests are another result of the co-operative system in America. In an industrial show held for several consecutive years in Cincinnati, previous to the Centennial in 1876, there were competitive trials of nearly all kinds of machines and implements. Machines for boring, planing, sawing, and turning metal and wood, with other machines, were operated for a given time on uniform material, the results tabulated by committees appointed for that purpose, and the results published. In almost any other country such trials would have been impossible, because of the effect upon the trade interests of those who came out last in the experiments; but not so there, where those who purchase implements judge for themselves, and where it was argued that if a maker was beaten he would at once set to work to surpass his successful rival, and most likely would do so in another test.

In America no one buys a machine or tool because it "took the first prize," or at least the importance attached to such awards is very little, so that in future shows it is probable there will be no specific awards given. People judge for themselves, and do not rely upon decisions made under peculiar and often unfair conditions, a kind of confidence arising mainly from the common knowledge gained by what has been called the co-operative principle.

Much more could be added in respect to the causes and indirect effects arising from such a system of free intercourse between engineers and manufacturers, but the purpose is to confine what is said as nearly as possible to the direct effect upon industrial production. One of these effects is the facilities which such free intercourse offers to foreigners for learning American practice.

Until within a few years past letters of introduction, or indeed anything else except a card, were not required to obtain permission to visit factories or workshops, and the same rule, without many exceptions, now applies to English visitors; but there is a growing distrust, especially since the Exhibition of 1876, against foreigners, especially North Europeans, which renders it much more difficult to visit and inspect factories.

With this we can scarce find fault, even if we do not compare it with our own system. There is a kind of selfish disregard too common in some of the north continental countries which permits an appropriation of inventions, which is as repulsive to Americans as it is to the English, a spirit which was very truthfully described by an American who remarked on seeing a Swede leave Philadelphia for home during the Exhibition: "There he goes with his pockets full of notes, his hat worn out with salutes, and as soon as he is clear of Sandy Hook he would care but little to know that the Exhibition was burnt."—*Engineering.*

WHAT THE ELEVATED RAILWAY ACTUALLY DOES FOR STREET ARCHITECTURE IN NEW YORK.

IT had been my pleasure, as it had been no doubt the agreeable occupation of many others as well, to take frequent strolls about the city, studying the buildings and finding amusement and profit in seeing what had been accomplished, and gaining warning and wisdom by the failures of others. But now upon several important avenues of the city this experience is enjoyed only in reminiscence, for with the rise of the elevated roads the opportunity to do anything in the way of sight-seeing is entirely gone. Before the streets were straddled by these gridiron structures there was opportunity to see the collection of buildings which make up the town, but now it is only by much care in selection that one may find a vista, where up and down the thoroughfare the eye may wander along the lines of buildings, and enjoy a panorama which can only be met in the heart of a great city. Do you not believe it? Come with me, and let us work our way up town, under the shadow of this thing, which stands at once a monument of American character and simplicity, shows with what a reckless disregard of cost New Yorkers set about securing their ends, and proves that their squandering is not all done during European trips.

We are at the Battery, where, if the will only existed, the finest residence in the city might be secured without any need of rapid transit. Turning into New Church Street, cut through at so great an expense but a few years ago, we find one end of the long iron ribbon. The street is dark and damp; not quite as dark as a tunnel, nor is it running with water, but it has not the bright, open sunniness that we have a right to expect. The first few blocks are ordinary warehouses, and not much is lost when they are cut off from view. To our right is the great pile of the rear of the Adams Express Company's building, worth looking at, but lost to view forever. Trinity Church comes next, and here the sacrilege of the road begins; not content with making a pandemonium of the neighborhood of the church, they have cut off what was one of the best views of it. The seven-lighted chancel window, with the quatre-foil in the gable, and the clerestory and the rows of pinnacles, bearing testimony to the honest, unambitious work of one of the first architects New York ever had, all are gone; while the Withers addition to the chancel end of the church, which we have hardly yet had an opportuity of seeing, is, as it were, smothered in its birth. Its effect may be good, as its details are certainly carefully studied, but it is gridironed out of sight. Across the street a lowly structure, now a vile smelling stable, bows its ancient head before the iron Moloch, and recalls the poet Bryant's natal year in the inscription over the door, "The Episcopal Charity School, 1794." Mr. R. M. Upjohn suffers no less than his father in having the Trinity schools cut off. To be sure, from Trinity Place the upper story and tower may be seen, but such disjointed views of a building are unsatisfactory, while the gargoyle heads at the tower corners look out as though to vomit their indignation upon the incubus below. St. Peter's School, on the street corner, suffers with its neighbor, showing that the railway is no respecter of creeds, as it surely is not of personal rights. The Liberty Street Police Station next is thrown into the shade, while the view of Liberty Street to the Mutual Insurance clock is another of the past privileges. The Coal and Iron Exchange suffers with a station directly at its side. The angle view of the building is gone, but then one can walk Church Street, even though it be in partial darkness, without catching a glimpse of that meaningless pediment and pair of columns which make the main entrance of the building so pretentious. St. Paul's Church, now the oldest ecclesiastical structure in the city, is not spared, and the view from Fulton Street across the old churchyard to the Wrenisle spire is gone, with all its associations. At the northwest corner of Vesey and Church Streets is an iron front worth the looking at if it could be taken in perspective; but now the only view is one in elevation, had with the penalty of an almost dislocated neck. The classic front of St. Peter's Church, at Barclay and Church Streets, from the opposite junction of three thoroughfares now shows only a few bases with bits of column attached.

We will be honest in our observation, not shut our eyes to the good points of the road, and note that at Park Place a providentially placed station hides in a measure the *Tribune* tower. But the road is leaving Church Street, and makes an ugly twist over the sidewalk at Murray street; and it is noteworthy with what respectful deference thus far even the busiest of those below avoid the chance of a crush, and give the iron horse the right of way below as he certainly has it above. When he has passed on we resume our walk. College Place lying low the posts run high, and the groping is rather less strongly felt. At Chambers Street the view up West Broadway and along to South Fifth Avenue can no more be taken. Thurber's store is there yet, about this point, but its cheek is rudely rubbed by the intruder. Claflin's wholesale house is caught by the iron band about the third floor, and on warm days the dust, smoke, and cinders flying in at the open windows can be no advantage to the fine goods. One result of having the road high is that all the little, scrubby shanties show off as well as ever. The little parks along the route are pounced upon by the station designers to drop their dog-legged stairs and threatening platforms upon. St. John's Church has a Renaissance tower, and looking up York Street it could once be fairly viewed, but can be so looked upon no longer. Jumping Canal Street, the comparatively new church of St. Alphonse gets whatever beauty it may have had effectually blotted from sight. Very considerately the road of South Fifth Avenue constricts itself, giving us a chance to still look upon the "dear cabin homes" which bolster each other up along this broad avenue, and give shelter to countless broods of pickaninnies. Along this section, too, the hollow box girders which are employed respond like so many sounding boards to the roar of the passing trains, and a capital imitation of heavy thunder is afforded the street passenger. At the corner of West Third Street is another twist and another passage over the sidewalk, and again the sub-ferruginous public respectfully stand aside. Here St. Clement's Church gets its quaint little face still further hidden. The Union Reformed Dutch Church wardens no doubt thought they had a choice site on Sixth Avenue opposite Third Street, but they must now take a very close view of their shrine, since the iron will of the contractors has cut off the long view. St. Joseph's Church, on the block above, never very conspicuous, is still less so now, and the Greenwich Bank building, by Mr. Thomas, architect, has lost its quiet dignity in the company of the mid-air rail. At the Jefferson Market Court House there is provocation for a downright anathema. We had hardly begun to get at the full merits of the tower and its attachments, and had only begun to enjoy this really good thing, when it is swept from our sight by this piece of convenient ugliness. The old Lutheran Church at Fifteenth Street, and the Jardine flats corner Fifteenth and Sixteenth Streets, suffer for their contiguity with the road by having all good view of them cut off. The modest bit of crude Gothic in the Church of the Holy Communion, corner Twentieth Street, has gone into an iron, in addition to its leafy seclusion.

At the corner of Twenty-third Street the road makes a double stroke, and decapitates at once Renwick's excellent bit of Italian in Booth's Theater and Le Brun's Masonic Temple. No doubt there are many who admire both of the buildings, but they can do so now no more. The confusion and the obscuration are intensified by the great platform built at this point. St. Omer's Hotel, under the flank of the Temple, runs chance of having its secrets exposed to the rattling passengers, while its garish face is lost to sight.

The Racquet Club building is the next victim of the road, and a real victim too, for it had a story to impress of honesty in construction, freedom from shams, and truth of expression which no other building of the city so well combines; but it is gone. It was one of the few building of the city that are really architectural in conception and treatment. Ah, here is another good point! By keeping carefully to the west side of Sixth Avenue the traveler may walk up and down without having the Union Dime monstrosity thrust in his face; for this, thanks. Dr Taylor's church once enjoyed a favored and conspicuous site, but now it takes its chance with the other victims along the line. From the opposite side of Reservoir Square the passing to and fro of trains makes a pretty spectacle; but Lyric Hall is out of view, and on the opposite way the churches on Fortieth and Forty-second Streets, with the Harmony Club House and the Hotel Royal, all go into obscurity to Sixth Avenue pedestrians. Above Forty-second Street a few showy flats have their gaudiness put out of sight by the road, though no one loses much except perhaps the owner, who finds pleasure in seeing brown stone tortured. At Fiftieth Street there was at one time a view up the street to the Roman Catholic Cathedral, where one tower could be seen, but the pleasure of this view is henceforth a mere remembrance. Dr. Hall's church and Dr. Morgan's church have towers and spires which are worth the looking at, but now the occasional glimpses that might have been caught over the house top or along the street openings are gone. At last we reach the Park, where there is a great pother of puffing dummies backing to and fro, making an escape into the Park a leap from Hades to the shady side of Elysium. With such a construction before him there is no encouragement for a property owner on the line to build a striking or expensive façade. And then think of the money sunk in attractive signs along the route! The four miles of the road render useless, because invisible to any large number of people, at least twenty thousand dollars' worth of signs.

But let us shake off the general dustiness we have gathered by the walk along the substructure of the road, forget the holes burned in our coats by hot cinders, overlook the few grease splashes upon our summer hat, and forgive the brakeman who found amusement in squirting tobacco juice down upon us, and let us go up and follow the unthinking populace in encouraging the monopoly. Oh, how delightful! Bless me, here we are at old Trinity again! I take it all back; let architecture and property rights and personal privileges and past associations perish, so long as we can so fly through the air without following suit.—*W., in American Architect.*

TESTING THE FORCE OF TORPEDOES.

MAJOR-GENERAL ABBOTT has been making a series of experiments with torpedoes at Willett's Point, with a view of ascertaining the relative force of gun-powder, gun-cotton and dynamite, and of measuring the force of the explosion under water at various distances from a torpedo. He has studied this so carefully for the past two years that he is able to tell exactly the destructive force of any given quantity of explosive substance in all directions at different depths. To ascertain this he has invented two methods of measurement of force—the ring test and crate test. The former consists of a thick iron ring, about seven feet in diameter. To the inside of the ring are attached six semi-tubular bars of iron about ten inches long, pointing toward the center. In the tubes there are placed small round bars of lead about one inch long and from one-quarter of an inch to one inch in diameter. The torpedo is placed in the center of the ring, which is then submerged in the water and attached to a buoy. A wire connects the torpedo with a battery on shore. When the torpedo is fired, the force generated by the explosive presses the water against the lead bars, which become compressed in different proportions according as they face the torpedo laterally or vertically. The force vertically or upwardly is greatest, and General Abbott has several lead bars, one inch in thickness, that have been compressed fully one-third of their length. The ring is used principally to measure the vertical force of the torpedo.

To measure the lateral force the crate test is used. The crate is a long iron frame-work, forty or fifty feet in length, in shape similar to a crate. The torpedo is fastened to the middle of this, and semi-tubular iron bars, similar to those used in the ring test, are employed. The lead bars for measurement are also used, their size decreasing in proportion to the distance from the torpedo.

An old 200-ton schooner has been used by General Abbott for carrying out and immersing the crate into the sea, where it is prevented from sinking to the bottom by buoys. Tuesday General Abbott intended to blow up the schooner, but first desired to obtain photographs of different periods of the explosion of torpedoes, and to use the schooner as a standard by which to measure the height to which the water was thrown. A gunpowder torpedo was sunk within twenty feet of the schooner and fired, the water being thrown up to twice the height of the schooner, which is sixty-five feet from masthead to water. In consequence of the cloudiness of the weather only three out of six negatives could be taken, and the General postponed the blowing up of the schooner until yesterday.

The old schooner was successfully blown up yesterday afternoon, amid cheers from a throng of spectators. Previous to this experiment, four torpedoes were exploded near

the vessel, one at the bow, another at the stern, and then two others at the bow and stern were exploded simultaneously. One of these latter had been sunk in four and the other in ten feet of water. The torpedo submerged four feet forced up the water in a tall, graceful jet over 150 feet in height. The other torpedo threw up a much larger amount of water, but only to an altitude of about eighty feet. The sails of the schooner were hoisted, a stuffed figure of a man was fastened to the rigging, and two kegs of powder, fifty pounds in each, were placed beneath the vessel amidships. On the dock, surrounded by his staff, sat General Abbott, in front of a table upon which was arranged an electric apparatus. At his right were four cameras, ready for taking instantaneous photographs of the explosion at different periods. "All ready," called out General Abbott, and pressed down the knob of the apparatus with his finger. Instantly there was a violent commotion of the water under the schooner. She snapped asunder as if made of pasteboard, with a loud deep report; her timbers were torn as if they were straws, and a confused mass of water, planks, fragments of wood, black dust and a volume of smoke, through which darted a large red globe of fire, was hurled up to a height of at least 130 feet. For a moment the whole mass balanced in the air and then fell. All that remained of the schooner was the top of the deck cabin. Of the remainder of the vessel no two planks were left together.

General Abbott stated that while the torpedo was an excellent arm for defense, the public seemed to place too much confidence in it, to the neglect of artillery and men. Torpedoes in naval warfare were what heavy artillery was on land. The latter could be captured if not supported by infantry and cavalry, and torpedoes could be grappled for and captured or rendered ineffective against a hostile fleet, unless supported by sufficient heavy land batteries. In this the fortifications at Willett's Point and other forts round New York were very deficient, and to-day the defenses of this city were far weaker than the people imagined.—*N. Y. Tribune, August* 8.

SELF-ACTING BOILER FEEDER.

IN this ingenious apparatus is solved, according to its inventor and builder, the problem of keeping a boiler continuously and steadily fed without attention from the stoker, or any other more or less willful or fallible agent. Its patentee, Mr. S. G. Cohnfeld, Eng., has contrived to avoid the use of a float, and the joints and stuffing boxes rendered necessary by it, and to build an apparatus which at least has the merit of possessing but few moving parts, so that wear, and with it the necessity for renewals, or the chances of unsatisfactory action, are reduced to a minimum.

The mode of action of the apparatus is as follows:—Supposing the feeder filled with water, and connected with the S, cause an excess of pressure on the lower side of S, in consequence of which the valve opens and the water in the reservoir, A, is driven through the feed-pipe, *e*, into the boiler. The uncondensed steam in A passes now through F' F, into A', and the water in A' journeys on through *e e'* to A. The steam in both reservoirs loses its tension by its expansion and the absorption of its heat, and a vacuum is thus created in A'. So long as this lasts, water is sucked

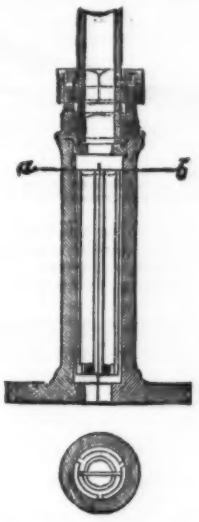


FIG. 2.—SECTION ON *a b*.

up through the tube, *i*, and the valve, R. The apparatus raises cold water 5 meters high, and water at 50° C. to 4 meters exactly. When the feed water is overhead, the apparatus will work with the temperature raised to 85°. In the drawing, *h* is an ordinary steam valve; *x* is an air reservoir, closed above or below by a light cork ball covered with India rubber; *y*, an alarm whistle, which on any interruption of the work of the apparatus, through the water being too cold or too hot, or insufficient in quantity, gives a loud signal, at the beginning of which the boiler is still sufficiently provided with water; and *t* is a blow-off cock.

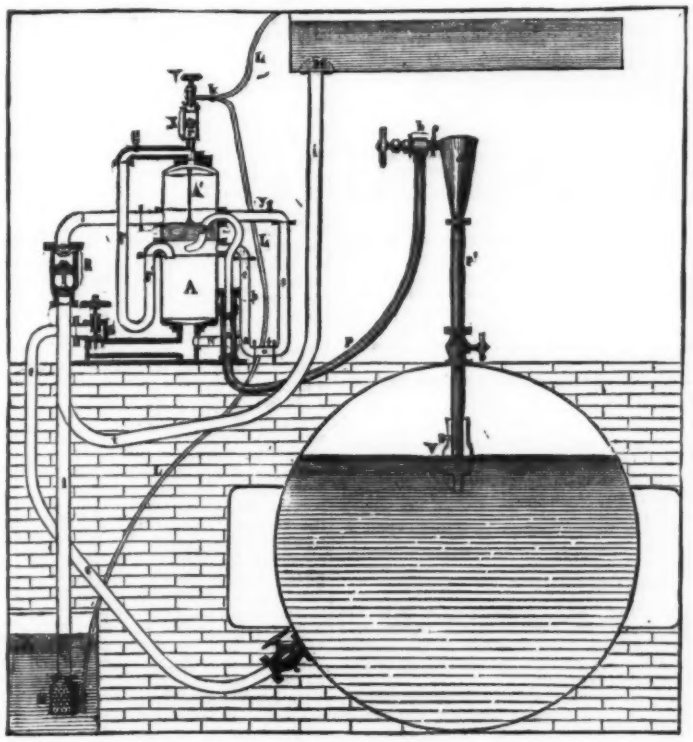


FIG. 1.—IMPROVED SELF-ACTING BOILER FEEDER.

boiler as shown in Fig. 1, water from the boiler is driven upward by the pressure of the steam, and passing into the tube, *e*, closes the valve at S, while, on attaining its normal level within the boiler, the water closes the end of the tube, *p'*, at V. This shows the position of the apparatus when the boiler is not at work. When steam is got up and the water begins to be consumed, its level sinks and steam finds its way at V into the tube *p'*, at the upper end of which is a steam drier, *d*, on which is screwed an inlet valve for steam, *h*. From here the steam passes into the so-called accelerator, *z*, shown in detail at Fig. 2. This is a stout cylinder, the weight of which is so calculated that under ordinary conditions it remains in its seat, and by means of the channels in its interior and the openings at its foot keeps a way clear between the steam-boiler and the feeder. As soon as a partial vacuum is created in A, and the pressure is thereby increased on the sides of the boiler, *z* rises and closes the way. The upper surface of *z*, however, is provided with a few small notches which give passage to a quantity of steam sufficient to prevent the acceleration from remaining in its second position. But for this contrivance *z* would remain fixed in its place when A was refilled with water, and the work of the apparatus would be brought to a standstill.

From the accelerator the steam passes through the swan's neck, *p*, into the lower reservoir, A, until the pressures both in this and the boiler have been equalized. This pressure, and the weight of the column of water pressing below upon The end of the tube, *p'*, has a cap to keep the tube free from accidental impurities in the water, and to preserve the metal intact from the effect of the motion of the water. The apparatus is constructed for the most part in copper and bronze, the bed and middle part only being cast iron. Where very high-pressure steam is worked with, bronze replaces cast iron in these latter portions of the apparatus. Over 400 of these feeders are said to be successfully at work in many parts of Europe. The collateral advantage is claimed for it that it leads to an economy of fuel, while at a little extra cost it can also be made to perform the duty of measuring the water it feeds into the boiler.—*Iron.*

CRIMINAL BOILER MAKING.

AT a justice's inquest upon the cause of the death of three men killed by the explosion of the steam boiler of the Boston Stamping Co., Third Street, Cambridge, Mass., on the afternoon of Saturday, April 6, 1878, the evidence disclosed a degree of dishonesty and recklessness in the construction and care of the boiler that was, to say the least, highly criminal.

The boiler was of 50 horse power, 17 feet long, 4 feet in diameter, and of the class known as a horizontal return tubular boiler. It contained originally 49 three inch tubes—2 of which had been removed—and from its great extent of surface exposed to the heat this boiler had a large capacity for generating steam. It was made by Thomas Cunningham, and placed in the factory in November, 1869, under the builder's direction. It was reported to be made of the best quality charcoal No. 1 iron. It was tested by a pressure of 150 pounds to the square inch, and a certificate of a United States inspector of steam boilers given that it was deemed safe for one year at a working pressure of 100 pounds to the square inch.

At the time of the explosion a large proportion of the daily work of the manufactory had been suspended. Mr. Seavey, one of the owners, inferred that not more than a tenth of the usual power was at work. The steam gauge, upon the testimony of William Plant, who examined it within one minute previous to the explosion, indicated a pressure of about 60. John W. McDonald, who left the room fifteen minutes previously, observed that the steam gauge stood at 65, and that there were two gauges of water. The starting valve of the pump, slightly open, was found in the ruins, showing that the pump was at work at the instant of the explosion. It therefore appears that at the moment preceding the disaster the strain upon the boiler did not materially exceed 60 pounds to the square inch, and that there was no deficiency of water.

There was no warning or intimation of danger. It was instant, terrific, and destructive. The building in which the boiler was set was totally destroyed, and the fragments scattered about as if a mine of gunpowder had exploded on the spot.

The man in charge of the boiler was killed. It was testified that he "was a good blacksmith, but knew nothing of taking care of steam boilers." The boiler itself seems to have been as little fit for the duty placed upon it. According to the evidence taken it was weak from the beginning, badly set, and had not been inspected from the time of its erection in 1869. The report of the inquest shows that:

(1.) The examination of the iron of the shell by thorough tests disclosed that instead of being of the best quality, as represented in the certificate of inspection, it was of a very inferior kind, utterly unfit for a steam boiler. It showed indications that these plates had been rolled from two qualities of iron—an inferior central plate veneered by covers of a better grade. So that while its tensile strength would sustain a strain that indicated safety, it was so brittle, as stated by Mr. J. H. Roberts, as to break under a slight blow with a seven pound hammer.

(2.) This boiler had faults of construction that made it insecure. The rivet-holes were too large, leaving the transverse seams particularly very weak; the stays of the back head were all attached to the back course, thereby throwing the pressure upon the rear transverse seam. The same pipe was used both for a feed pipe and as a blow-off pipe; the boiler was so set and fed that the circulation was defective, and there was no place for the safe deposit of sediment, and no hand hole for its removal except at the front; there was no fusible safety plug.

(3.) It also appeared that the setting of the boiler was so faulty that soon after its erection the whole of the bottom was exposed to the direct action of the fire, as also the dry smoke-box, which was frequently burned out.

The justice found grave delinquency in the construction of the boiler, in the neglect of proper inspection, and in the intrusting of it to the care of an incompetent engineer. But we find no recommendation that either builder or owner be held to account for his responsibility in connection with the disaster.

FIRE-PROOF CONSTRUCTION.—II.*

THE shafts of cast-iron columns should be continuous from middle to middle of the floor thickness, enveloped with not less than one inch of some fire-proof, non-conducting material, securely held to the shaft by buttons or ribs imbedded in the material. The capital and base should be of cast or

CAST-IRON COLUMNS.

No portion of the constructive iron work exposed.

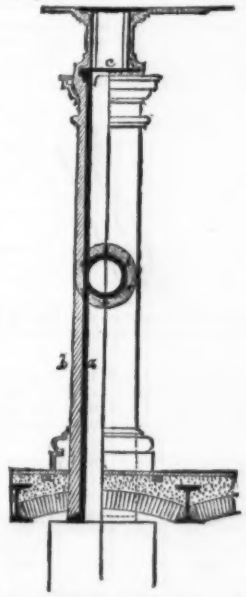


FIG. 6.—Inner shell of shaft *a* of cast-iron; *b*, protecting envelope of a fire-proof, non-conducting material.

sheet iron, fastened to lugs or bosses cast on the shaft and long enough to pass through the envelope (see Figs. 6 and 7).

If light partitions are required, such as do not start from the foundation, and for which common brick would be impracticable by reason of its weight, hollow terra-cotta tile or brick can be used. Another method, more expensive, but admitting a construction which is self-supporting, consists of light I-beams, generally four inches deep, placed vertically two feet from centers, with the ends riveted or bolted to plates or channel-irons secured to the floor and ceiling; to these beams the iron lath is bolted for receiving the plaster. These partitions can be readily trussed, so that they add no weight to the floor from which they start.

All steep parts of slated roofs are provided with rolled iron purlines, T or L shaped, weighing about two pounds per

* A paper by F. Schumann, C. E., read at the last annual convention of the American Institute of Architects.

linear foot, riveted to the jack-rafters or trusses. The spans of these purlins should not exceed six feet for slate weighing ten pounds each. The distance between centers of purlins depends upon and is always equal to the weathering of the slate; one purlin is required for each line of slate; for example: A slate 12x24 inches, showing ten inches to the weather, with four inches lap, requires the purlins to be ten inches from centers. The slate is fast-

SECTION ELEVATION.
No part of the iron exposed.

FIG. 7.—Cast-iron column protected by 4½ ins. of brick. Instead of girders, brick arches are sprung between columns for supporting the floors.

ened to purlins by No. 16 B. W. G. copper wire passing through two holes in the tail of the slate and around the purlin (see Fig. 9). Another method, more expensive, but in proportion to its greater security, consists of two 3-16 inch diameter bolts with heads countersunk in the slate, and fastened with a nut to a hook hanging to the purlins (see Fig. 9). Instead of purlins, corrugated sheet-iron is sometimes used, running from rafter to rafter; to this the slate is fastened by wrought iron pins, countersunk and passing through the slate and corrugated sheets, where they are bent so as

SLATED ROOF.

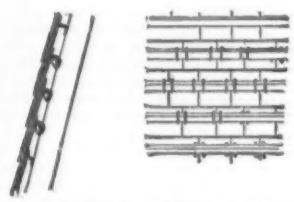


FIG. 8.—INSIDE VIEW OF SLATE AND PURLINS.—Slate fastened to L or T shaped rolled-iron purlins with No. 16 B. W. G. copper.

to form a hook or clinch; the slate may also be bedded in a layer of cement applied to the corrugated iron (see Fig 10).

Flat parts of roof are covered with either cement, copper, lead, zinc, tin, or galvanized sheet-iron; either one of the metal coverings is fastened to a layer of cement, about

FIG. 9.—Wrought-iron countersunk bolt, $\frac{3}{16}$" diameter, and hook, 1" x ¼", hanging to purlin.

one inch thich, overlying concrete supported by corrugated sheet-iron arches, by the tags imbedded therein (see Fig. 11). The supporting material may also consist of burned clay tile, resting on T-irons (see Fig. 12). Another very

FIG. 10.—Slate fastened to corrugated sheet-iron by wrought-iron countersunk pins. Slate is also bedded in a layer of cement applied to corrugated iron.

good method consists of metal boxes filled with fire-proof material; the boxes are about two feet wide, from two to three inches deep, and of lengths up to eight feet spans; the bottom, sides, and ends are formed of galvanized sheet-

FLAT ROOFS COVERED WITH METAL SHEETS OR CEMENT.

FIG. 11.—ARCHES OF CORRUGATED SHEET-IRON No. 20 B. W. G.—Weight of construction from 40 to 60 lbs. per square foot. *a*, corrugated iron arch; *b*, rolled beams; *c*, concrete filling; *d*, layer of cement; *e*, metal tags for fastening metal cover.

iron, and the top of copper or galvanized sheet-iron; the boxes are placed alongside of each other and fastened to the beams of the roof. This method possesses an advantage in that it is light, strong, overcomes the difficulties from

FIG. 12.—BURNT CLAY TILE, ABOUT 16 INS. SQUARE AND 3 INS. THICK.—Weight of construction from 15 to 20 lbs. per square foot. *a*, tile; *b*, rolled T-irons weighing from 3 to 6 lbs. per linear foot; *c*, layer of cement about 1 in. thick.

expansion and contraction, and forms a smooth ceiling (see Fig. 13).

Fire-proof doors and shutters are indispensable. They consist either of sheet-iron boxes filled with fire-proof material, or layers of corrugated sheet-iron riveted together; they are also made of a sheet-iron plate surrounded by an iron frame forming an open box, into which a fire-proof preparation is filled and secured by lath of a peculiar construction; this is an effective shutter or door, in that the fire-proof material is directly exposed to an encroaching fire and no part of the metallic construction is in danger of warping and the material falling out. It is essential, to insure a proper working condition of shutters in warehouses or factories, to so construct the shutter that it can be attached to the glazed sash,

FIG. 13.—METAL BOXES FROM 6 TO 8 FT. LONG, 2 TO 3 FT. WIDE, AND 2 TO 3 INS. DEEP.—Weight of construction from 12 to 15 lbs. Boxes are filled with non-conducting fire-proof material.

and that both will slide on the same bar or track, so that the sash cannot be opened without also moving the shutter. In buildings where subdividing fire-walls are made use of, it would be well so to arrange the shutters that they can be

FIG. 14.—ORDINARY FLOORS.—Maximum weight 40 lbs. per square foot. The filling may consist of clay mixed with cut straw. *a*, joist; *b*, counter-ceiling; *c*, wooden ceiling; *d*, flooring; *e*, fire-proof, non-conducting filling.

operated from an adjoining room or compartment by means of rods or endless chains.

Class III. All girders, joists, struts, and roof timbers to be of wood, and, if possible, of large scantling. All floors to

FIG. 15.—ORDINARY FLOORS.—Maximum weight 30 lbs.; is more effective than Fig. 14 against fire from below.

be counter-ceiled so that not less than two inches of non-conducting material will lie between the flooring and counter-ceiling. The spaces between the scantlings of partitions to be filled with mortar or a mixture of clay and cut straw not

FIG. 16.—SUITABLE FOR HIGH ROOMS.—Joist of large scantling from 4 to 8 ft. apart. Maximum weight 50 lbs. The dotted line represents a continuous coarse wire netting, nailed to joist and imbedded in the filling; it is for the purpose of retaining the filling in place should the ceiling boards be burnt through.

less than one foot above the floor level (see Figs. 14, 15, 16).

The roof construction may be of wood. For the slated parts strips of wood 2x2 inches are nailed horizontally to the sheathing boards; the spaces between strips being filled, level with their tops, by a mixture of clay and cut straw or any other fire-proof non-conducting preparation. The same method is also used for flat parts of roofs, the metal tags for holding roof covering being nailed to strips.

The sketches hereto attached illustrate the various methods described.—*Amer. Architect.*

MR. C. BROWN, Director of the Swiss Locomotive and Machine Works at Winterthur, states that the 100 horse-power condensing engine described in No. 131 of the SCIENTIFIC AMERICAN SUPPLEMENT and the tank locomotive illustrated in No. 132 of the SUPPLEMENT are fitted with his patent valve gear. His United States patent is dated April 9, 1878.

CONDITIONING.

THE term "Conditioning," or "Conditioning of Silks," is perhaps unknown to the greater portion of the public, and among those who do understand the meaning of the expression there are certainly many who are ignorant of its origin. An explanation then seems necessary.

Silk is a very hygrometric substance; it contains normally, and under ordinary circumstances, a certain amount of water subject to considerable variations. These variations of weight that the same portion of silk may undergo according to the influences to which it is submitted may be readily observed by means of a balance. Indeed, according as the silk has been allowed to remain in a dry or a wet place, so will the results of the weighing sensibly differ. The expensive nature of the fiber makes this a serious matter. If it is a question, for instance, of a bale like those found in commerce, these differences are not only figured in grammes but even in kilogrammes, whenever the equilibrium has adjusted itself between the hygrometric state of the entire mass of material and that of the surrounding air.

It is ascertained, then, that the same bale exhibits during the damp weather peculiar to some seasons a weight much greater than that which it shows during the heat of summer, or during certain very dry cold days of winter. The influences of currents of air have to be equally avoided. Thus, when a bale of silk has been transported for a considerable distance by railway it is almost always discovered that it weighs less on arrival than it did at its departure.

From these observations it may readily be conceived to what extent the hygrometric state of the house in which the silk is stored may modify the weight of this fiber.

This fact has been known for a long time, and commerce has always endeavored to protect itself against the risks of a diminution of weight of the precious material, by avoiding such storage places as were too dry. Unfortunately, however, dealers were not always honest enough to stop just at this point, but, led on by the desire of an easy gain, very often stored the merchandise in places that were always damp, such as cellars, subcellars, etc.; and these places they often took the precaution to sprinkle, in order to be on the safe side!

From the remotest times silk has possessed great value; just before the war of 1870, certain exceptionally fine qualities of the raw material were estimated in Paris at 175 francs per kilogramme, or almost seven-eighths the price of fine silver.

It is easily imagined, then, what perpetual contests must have taken place between buyers and sellers in relation to an article of merchandise about the condition of which there could always be some ground for doubt.

In order to put an end to such difficulties, as well as for the purpose of giving a more moral tone to the trade, the idea was conceived, first at Turin in 1750, then at Lyons, St. Etienne and Saint-Chamond, and finally at all other great silk markets, of establishing vast rooms, which were placed at the disposal of merchants by private individuals. These storerooms, protected as much as possible from variations of the atmosphere, were kept constantly at a fixed temperature by means of hot air stoves. The bales of silk were brought to these places, opened, and their contents exposed to the surrounding air during a period fixed by the regulations (two or three days usually), in order to acquire the desired degree of desiccation. Dealers then had (or at least they believed they had) some guarantees as to the state of the merchandise, and they called it *in good condition*. It was now weighed, and the bargain was concluded according to the weight thus established.

By a singular caprice of language, the places which served for this kind of verification were at length called *Conditions*, while the proof of the verification itself, by a further extension, was called *Conditioning*.

In 1805 official Conditions were established in France, and the Government suppressed all those that had been managed by private enterprise. Thirty years later, M. PERSOZ, who had presided over the Conditioning office at Paris, studied and in conjunction with M. Talabot, completed a system which is still in use. These two scientists invented a drying apparatus which now bears their combined names.

At present, instead of drying whole bales, samples are taken here and there, weighed, and rendered absolutely dry at a temperature of 102 to 108 degs. Centigrade, and being again weighed, the quantity of moisture driven off is ascertained, and sales are thus based on absolute weight, increased by that of the normal or average amount of water.

In practice, the system is to take 30 meshes from a bale, and to make them up into three lots, one of which is held in reserve, while the other two are dried in different machines and weighed; if the difference between the results is more than half per cent., then the first lot is dried in the same way, and an average taken. In some establishments Conditioning is also applied to cotton and wool, and it has been agreed that it should also be applied to flax.

JAPANESE FIREWORKS.

JAPANESE night fireworks are of two kinds, ground displays and rockets. Day fireworks are exclusively of the latter kind, for obvious reasons. Effect can only be produced by them in the air and at a distance, and as many of them consist of more or less somber imagery traced in smoke or cloud, a clear blue sky is the best background for their disclosure. The full success of this, again, is dependent not only upon a clear atmosphere, but also on perfectly calm weather or the gentlest of zephyrs. The morning of our visit exemplified this; the heavens were as lead in color, and a brisk breeze was blowing off the land. Notwithstanding this, the proprietor courteously insisted upon sending up a couple of his magic cases, as unlike the foreign rocket as can well be conceived. Out of one of these burst clouds of variegated hue, with fantastic accessories, but which were blurred and smothered by the murk behind. From the other emerged a tricolor flag, which was seized by the wind and borne rapidly far out into the bay, "mere waftage of the air." Night and day rockets—we must use this word for want of a better—are neither of them self-propelling. They are shot perpendicularly into the air from mortars imbedded in the soil at right angles to the horizon. Perfect accuracy of flight is thus insured, a result hardly attainable with the Western stick and self-propulsion system. The ordnance is made of wood—very often mere pine, though camphor-wood is preferred. Every mortar is composed of two pieces, each like half of one of the metal mortars in use among our armies, supposing the instrument to be split downward from the mouth to the breech. A touch-hole is bored in the lower extremity of one of these half tubes, and the two are then solidly and tightly bound together with bamboo strips, just as buckets and tubs are coopered, but continuously from end to end. The engine is then complete. It only remains to plant the solid portion of the butt firmly in the ground, and all is ready for action. These toy mortars are of various sizes, from a foot or 18 inches to 7 feet in length, and with a diameter, within the tube, of from 1½ to 6 inches. A good one will bear 700 or 800 discharges. The extreme ordinary range is 1,200 yards, though a higher elevation can be obtained by affixing wings to the missile. This latter is sometimes of spherical but generally of cylindrical form. In the latter case the bursting charge is contained in a globe at the bottom of the cylinder. Suppose one of these about to be discharged. A mortar of suitable bore is sponged out, a charge of powder is dropped into the muzzle, a quick fuse is put into the touch-hole. If you have looked closely at the projectile you have seen at the flat extremity two little loops of twine, the object of which may have puzzled you. It is now apparent. The operator passes through them, from side to side, a piece of stout cord, with the aid of which he lets the firework carefully down till it touches the charge, and then withdraws the cord. A fire-stick is applied to the fuse, and instantly the contents of the gun are hurled straight into the air. Now, as we said above, the bursting charge is in the globular portion of the bomb, and this part is lowest in the gun, so that its time fuse, communicating with the detonants, may ignite with the discharge. But the whole case is so weighted that, as soon as it leaves the muzzle, top and bottom are reversed, with the result that the fuse burns and the explosion or explosions take place upward, the wisdom of which arrangement will be at once apparent. There is practically no end, excepting the period of descent of the case or its component parts, to the number of "surprises" which could be put into one rocket, in which both for night and day exhibitions the system followed is the same—explosive charge, compartment, dragon or stars; explosive charge, flag, or luminous crysenthema; explosive charge, etc., to the end of the chapter.

We will now tell as much as we dare, or it would be fair to say, of what Mr. Hirayama puts inside his missiles. And we frankly confess that, compared with what we do not know, what we do know is very little indeed. Certain questions could neither have been properly asked nor wisely answered. Moreover, if his own artists keep him in the dark as to many of their operations, what could be expected of

him or them toward a stranger? The brighter and more expensive of the figures emitted from smoke or cloud are made of silk; by far the greater number, however, are formed of a very soft, light, but singularly cohesive paper. In the case of dragons, tigers, fish, birds, and such like, the material is cut, sewn, and painted in the form and colors of the object intended to be represented. But this is not enough. It is necessary that the image shall assume its proper posture in the air, when released from the space in which it is folded and packed as lightly as possible; that it shall float lightly and descend but gradually. To insure this requires, as may be imagined, great nicety of adjustment of the flimsy texture. Small leaden weights are disposed here and there about the figure, and small circular holes are cut in carefully determined spots of the belly, back, legs, and head for the admission and exit of the air which keeps it inflated. Flags and banners, pictures and screens, are in one piece; their folds are opened, and they themselves are kept continually in a visible position to the eye in the flight and descent by small weights, as above, but only on that edge which should be downward. All of the simplest and many of the more elaborate cloud effects are produced by colored earths of fine consistency, judiciously disposed; others are the result of the combustion or aerial commixture of certain chemical substances.—*Tokio Times.*

IMPROVED OATMEAL.

A SCOTCHMAN in Nebraska has patented a kiln for drying oats, whereat a correspondent of the *Aberdeen Herald* remarks:

It looks rather out of the proper way that a man should come from the land o' cakes to make improvements in the manufacture of oatmeal. Nevertheless there is something in the social atmosphere of this country that tends to develop ingenuity more than the conservative surroundings of Great Britain. What a laborious and unhealthy occupation is that of attending to the kiln which old country millers have been pleased to hand down for nearly a century now—a finishing stroke for old men who have become unfit for regular outdoor labor! My friend has effected an arrangement whereby the drying is accomplished on circulating cast-iron plates heated by steam. There is none of the filling, the turning, and "teeming" of the kiln required. The miller has only to let on the feed, and the oats come out in rather less than twenty minutes so hot that you could not hold your hand in them. They are also now more crisp and sweeter tasted than when they came through the unequal and uncertain reek of the old kiln. The amount of heated surface is about 500 square feet; there are a series of plates, and the grain descends from the one to the other, being distributed by a series of revolving arms or shovels, and the amount dried by the process is about 200 quarters in 24 hours. This small nut, I apprehend, will be about as hard for your millers and farmers to crack as is the statement that plenty of good beef can be raised in this country. Nevertheless, the thing is an accomplished fact.

MILK AND ITS PRESERVATION.

AN English paper some time ago collated all the chemical facts in relation to milk, its adulteration and preservation, from which we extract the following paragraphs of interest:

Cows' milk, of average quality, contains from 10 to 13 per cent. of solid matter when evaporated to dryness by steam heat, and has a mean sp. gr. of 1·030; while that of the skimmed milk is about 1·035; and of the cream, 1·0244 (Ure). The average cream of cows' milk contains 4·5 per cent. of butter, 3·5 per cent. of curd, and 93 per cent. of whey (Berzelius). The skimmed milk consists of water, 92·9 per cent.; curd, 2·8 per cent.; sugar of milk, 3·5 per cent.; lactic acid, lactate of potassa, and a trace of lactate of iron, 6 per cent.; chloride of potassium, phosphate of potassa, and earthy phosphates (lime), 2 per cent. (Berzelius). Perfectly fresh milk is slightly alkaline, but soon becomes acid on exposure to the air, and after a time white coagula of casein (curds) separate from it. This change is immediately effected by the addition of rennet or an acid. That from the first, when dried and pressed, constitutes cheese.

The common frauds practiced by milk dealers are the addition of water and the subtraction of part of the cream. Sometimes potato starch is added to the milk, to give it a creamy or rich appearance, and this addition is still more frequently made to cream, to increase its consistence and quantity. The presence of potato starch may be determined by boiling some of the milk with a little vinegar, and, after separating the coagula by a strainer and allowing the liquid to become cold, testing it with solution or tincture of iodine. If it turns blue, starch, flour, or some other amylaceous substance has been used to adulterate it. In most cases it will be sufficient to apply the test to the unprepared suspected milk. It has frequently been stated that chalk, plaster of Paris, gum, gelatine, sugar, flour, mucilage of hemp seed, the brains of animals, and other similar substances are often added to London milk, but there is no reason to suppose there is truth in these assertions, as some of these articles are too costly to be used, and the presence of others would so alter the flavor or appearance of the milk, or would so soon exhibit themselves by subsidence, as to lead to their detection.

Milk may be preserved in stout bottles, well corked and wired down, by heating them, in this state, to the boiling point, in a water bath, by which means the oxygen of the small quantity of inclosed air becomes absorbed. It must be afterward stored in a cool situation. By this method, which is also extensively adopted for the preservation of green fruits, vegetables, etc., milk will retain its properties unaltered for years. A few grains of carbonate of magnesia, or, still better, of bicarbonate of potassa or soda, may be advantageously dissolved in each bottle before corking it. Under Bethel's patent, the milk or cream is scalded, and, when cold, strongly charged with carbonic acid gas, by means of a soda-water machine, and the corks are wired down in the usual manner. The bottles should be kept inverted in a cool place.

An excellent method of preventing milk from turning sour, or coagulating, is to add to every pint of it about ten or twelve grains of carbonate or bicarbonate of soda. Milk thus prepared may be kept from eight to ten days in temperate weather. This addition is harmless, and, indeed, is advantageous to dyspeptic patients. According to D'Arcot, 1-2000th part of the bicarbonate is sufficient for the purpose. An excess of alkali used in this manner may be detected by the milk turning turmeric paper brown, even after it has been kept some hours, and by the ash obtained by evaporating a little to dryness, and then heating it to dull redness, effervescing with an acid.

Milk Powder.—1. Fresh skimmed milk, 1 gallon; carbonate of soda (in very fine powder), 1½ dr.; mix, evaporate to one-third by the heat of steam or a water bath, with constant agitation; then add of powdered white sugar 3½ lbs., and complete the evaporation at a reduced temperature; reduce the dry mass to powder, add the cream (well drained) which was taken from the milk, and after thorough admixture put the whole into well-stoppered bottles or tins, which must be at once hermetically sealed.

2. Carbonate of soda, ½ dr.; water, 1 fl. oz.; dissolve; add of fresh milk 1 quart; sugar, 1 lb.; reduce it by heat to the consistence of a syrup, and finish the evaporation on plates by exposure in an oven.

About an ounce of the powder agitated with a pint of water forms an agreeable and nutritious drink, and a good substitute for milk at sea. It may also be used for tea or coffee in the solid form. This process, which is very old, has been recently patented.

CARBONATE OF SODA.

By EDWARD DUNMORE.

As this preparation is frequently used by the photographer, more especially since the introduction of alkaline development, the ability to distinguish good from inferior samples is a matter of some importance, as the success or failure of a troublesome experiment may and does, in a great measure, depend upon the quality of the chemicals used. The failures we see recorded from time to time in our photographic literature would probably be explained if the quality of the chemicals was rigidly examined.

The purity of carbonate of soda, being an article of everyday use, is, as a rule, taken for granted, its comparatively small cost being considered sufficient warranty for its unsophistication. Carbonate of soda at a penny an ounce, or two ounces for three halfpence, should be avoided by the photographer as utterly unsuitable for his work, and likely to lead him into difficulties. I had occasion during this summer to purchase a packet neatly done up, sealed, and labeled "best carbonate of soda," but, to my surprise, litmus paper placed in a solution of it was changed bright pink. How such an impure sample would influence the delicate reactions that take place in the development of a dry plate the reader must determine. I merely call attention to the fact.

Carbonate of soda is the usual designation of bicarbonate, sesquicarbonate, or carbonate, each preparation differing from the other, sometimes considerably, so that a loose nomenclature of this kind is apt to mislead and is much to be deprecated. The differences in these soda preparations are these: Washing soda is a very impure carbonate, containing about twenty-two per cent. of real alkali; pure carbonate of soda is the same, *minus* impurities; bicarbonate or sesquicarbonate—an appellation used indiscriminately—contains about forty per cent. of real alkali, being, therefore, much stronger than the carbonate. It is the kind usually prescribed, and for general purposes is the best preparation.

In purchasing, "Howard's" best bicarbonate of soda should be asked for. It is usually kept by all respectable chemists, and is acknowledged to be the purest make and a thoroughly reliable article. The price is rather higher than that sold in packets, but the little difference is unworthy of notice. Unless, therefore, "carbonate" is expressly prescribed, Howard's bicarbonate may be safely used for all purposes that carbonate of soda is generally used for, especially for those purposes for which the photographer is likely to require it.

THE FACE IN SHADOW.

By W. HEIGHWAY.

THERE is apparent in photographic portraits where the shadow side is treated a great want of transparency and *color*—the color of the blacks. This we have already spoken of as the quality of the shadow.

On the face in shadow we find plenty, and to spare, of shade, but it is too flat and inharmonious, lacking life and vigor, and all that renders a portrait interesting. The monotony of this class of photograph is pitiable.

This want of quality in the tone of the darks extends of necessity to the whites, greatly heightening the harshness of contrast. With the lighted side of the face of blank whiteness, flat as a white-washed wall, the shaded side muddy and dull, the delicate modeling of nature is entirely lost, and we get in its place a hard wedged-shaped thing of wooden aspect.

The beauty of a perfectly shaded picture is due more to the judicious management of the darks, and the harmonious arrangement of the lights, than to the forcible contrasts and any sensational effect. This attainment of eccentric effect appears to be the prevailing idea in the minds of photographers of the intention of shadow pictures, and the result might almost be described as the lightning-and-thunder-cloudoscuro.

The brilliancy of the lights should be due almost solely to the contrast of the darks in opposition, certainly not to their own excessive and forced whiteness.

Brilliancy will not come of whiteness and blackness—harshness will, though!

Where prominence is given to the darker side of the face, the interest being centered there, all our attention and skill must be directed to the production of the shadows in all their beauty and perfection. With the two tints commonly attained, one representing the lights and the other the darks, it cannot be supposed that the requirements of art are satisfied.

I do not talk of "flitting shadows" and "sweet poetic lights" as elements of photographic lighting, but just of means that are well within the reach of any one who, with intelligence and the exercise of a little thought and trouble, will care to avail himself of the powers he possesses.

Beauty depends very greatly on our treatment in pose and arrangement, and more especially in the management of light and shade. Take the most beautiful head, and face it to the light, and photographing the light side the result will be miserably flat and uninteresting, even if we have not succeeded in rendering it positively ugly. Take the flatly shaded side, and the result is worse still. Amiability itself may be made to appear savage by excess of top light; jolly rotundity, worn and haggard by strong side light.

To get fine shadow effects the light must be pure and strong, and admitted through a small opening. The shadows are never too strong where perfect modeling is kept, and the lights will not be harsh, for though you may attain to the extremest contrast, harmony cannot be lost. It is only with weak light that harshness appears, and in the loss of middle tints hard and inharmonious transition from whiteness to blackness is induced.

Whether light or shadow predominate in our picture, it is the middle tones that give roundness.

For instance, let us place a white ball on a table in the position ordinarily occupied by the sitter, and carefully illuminate it. We find on the side nearest the light a perfect gradation of tone to a spot of pure white, and on the shadow side an equally unbroken gradation of shade with a small point of perfect black, both effects realizing the rotundity of the object. If our manipulation of the light does not secure the effect of roundness we know exists, it is clearly at fault. So in the proper degree with our illumination of the human face.

When you have secured perfect rotundity in the lighting of the ball, you have learned some very useful hints for the illumination of the sitter—but (need it be said?) a face ought not to appear as round as a ball. Do not abuse a power!

The face, properly shaded, should appear to grow out of the background—distinct from it, yet not cut sharply out in the outline. It is not necessarily a fault that in parts of the shadow side outline may appear to be lost in the background.

Above all, it must be understood that in advocating roundness as a quality of good lighting in effects of shadow, that rotundity which is so deceptive as to lead the spectator to the belief that he might take a stroll round the figure cannot be too strongly censured.

Even where the light comes from a point almost directly behind the sitter, the harmony between the tones on the face and that of the background must not be lost. It will be seen that if the background is too light, the outline of the face on the bright side may be entirely lost; this, it were needless to say, is to be avoided.

Take care that the small speck of light in the eyes is in both eyes alike. Sometimes it is found to kill the form of the dark center of the eye, when you may be assured that the lighting is at fault, and change of the sitter's position or of the illumination is necessary.—*Photographic News.*

RETOUCHING.

THE negative being placed on the frame, the light should be regulated according to its density—the greater the density of the negative the stronger the light required—taking care always to use the lowest degree of illumination consistent with complete visibility of all detail and half-tone. If too strong a light be used the retouching will show more forcibly than appears in the negative, and would ruin its delicacy. The aperture in the retouching easel should not be too large, or there will be a flood of light running into the eyes that will not only dazzle and tire them, but render the lighter and more delicate tones invisible. The plan we adopt is to have a sufficiently large aperture to see the greater part of a *carte* negative, for instance, and to diminish it while working by placing on the negative a piece of black cardboard in which a hole about an inch in diameter has been cut out. The pencil is to be pointed, the final "sharpening" being best given by a piece of emery paper or cloth not too fine, a little care being necessary to avoid breaking the long and fine point. The easiest and surest mode is to work the point by repeated strokes away from the body, and not to rub it sideways or backward and forward. This hint will be found very useful, as the breaking of half an inch of point is very irritating. We have not had much experience with the "ever-pointed" leads, our preference being for the ordinary make of blacklead.

Our mode of practice is to take out of faces all freckles and marks, blotches of unequal color, etc., first, and then very carefully to make the smallest possible amount of alteration in what is usually termed the "modeling"—that is, softening very heavy shadows and increasing the prominence of some of the leading lights. This is done by delicate "dabs," or dots, so to speak, with the point of the pencil, which must be made of the right intensity at once, as the depth cannot be increased by successive washes of color, as in painting, though if the retouching be done in very fine dotting or stippling, extra depth may be got by carefully filling in between the first pencilings.

The terms "stippling" and "hatching," as they are often employed, may be briefly described as dotting and lining respectively. When there are transparent parts requiring a considerable amount of intensity given to them it will be found next to impossible to do it at once, and then the only plan is to make the first retouching upon the *roughened varnish* as deep as possible, to soften by the aid of alcohol vapor, and then to heat strongly. This will fasten the retouching, and allow another coat of varnish, quickly applied, to be given. After the spots are all taken out by stippling, the modeling may be done by hatching, making small lines only, as regular in size and distance apart as possible, and, as much as can be done, causing them to follow the lines or contours of the features, or those particular facial developments that are being worked upon. It is important that the hatching should be done in a regular manner, or a very scratchy and uneven effect will be produced. Great care must be taken to avoid crossing the lines, or making two strokes touching one another, this being a fertile source of "lumpy" or "scratchy" work, as it is forcibly called.

It will be found of great use, if not an actual necessity, to have a magnifier for especially delicate work—not to be made use of from beginning to end, but merely for particular portions of the work, and to aid a general scanning of the whole when completed, so as to pick out any unevenness or roughness. If used all through it causes the work, strange as it may appear, to be less real and flesh-like and, we might almost say, less delicate. The glass should be of good width, so that both eyes can be used, and it is better if it can be affixed to a permanent support which will hold it at one distance from the negative; and this will materially lessen the fatigue of the eyes in using it.

The hatching may be suitably begun at the forehead and finished at the lower part of the face, working from the highest lights to the shadows, and not *vice versa*. We do not intend to enter into a description of the anatomical development of the face, but, instead, we say go to nature. Every face will impart hints as to the leading lights and shadows under varying modes of illumination. A gentleman who was one of the earliest of retouchers in this country used to make a point of scrutinizing his own face in a mirror, observing the disposition of high lights and shadows under every possible variety of illumination, and he recommends the method still as being better than all the books in the world. To the younger members of the profession we,

apart from its entire desirability from other points of view, strongly recommend a study of drawing; the benefit would be great in many ways.

We conclude by pointing out some alterations which may be made or avoided with advantage. One of the commonest faults of a photograph is the stern or "cross" expression so frequently seen, which is caused by a too strong light, or it is the natural expression of a face at rest. One of the chief sents of this expression is between the eyebrows. It is not caused by the perpendicular line or lines, more or less pronounced, always seen there in persons somewhat advanced in life, but is produced by the contraction of the eyebrow, which at the end nearest the nose will be found, when under this expression, to have taken an angular form, and produced a decidedly darker shadow underneath in the orbit. If the corner of this angle be taken off, and the heavy, dark shadow be slightly lessened, the effect is at times almost magical; and yet any one can see, by looking at a retouched negative that very few retouchers are aware of this simple expedient, it being generally thought that the upright furrows cause the frown.

It is generally advised to heighten the toning of the eyelids. We can only say, except to such experienced artists as need no advice from us, "do not touch them," for in ninety-nine cases out of a hundred the face gets spoiled by such work. That portion of the cheek nearest the nose should be most carefully and thoughtfully done; there is often a delicate shadow which is liable to be taken out by the unskilled retoucher with the effect of producing a swelled cheek. The line often found running down from the wings of the nostrils should be carefully lightened with the aid of the knowledge which would be obtained by a slight study of the artist's own face in a mirror. The difference between a smile and a sneer is caused by an almost imperceptible difference in the shading of this furrow that cannot be conveyed in words.

Finally, there is the corner of the mouth, where much may often be done if it be borne in mind that in a smile the corner of the lip is slightly turned up, and with a serious, grave, or crying expression it takes an opposite direction. The hands may often be improved by taking out the swollen veins they frequently present in the photograph, though often it happens that this can only be done on each individual print.—*British Journal of Photography.*

EXAGGERATION OF RELIEF.

A person possessing only one eye has no adequate idea of the effect or value of distance. The faculty of estimating the nearness of one object compared with another situated in the same direction depends mainly upon a system of triangulation, in which both eyes of the observer form the base of a triangle the apex of which is the point under observation, the convergence or the parallelism of the optic axes serving as an insensible means of appreciating the relative distances of the objects observed. The longer the base of this triangle the more delicate will be the appreciation of these measurements; from which fact it will be correctly deduced that while a one-eyed person cannot estimate distances unless by the aid of aerial perspective, a person whose eyes are separated by a greater width than usual will have a more delicate perception of relative distances.

Before proceeding to speak of a certain photographic application of this principle we shall describe a little instrument by which the effect of distance is greatly increased and intensified, owing to its being the means of effecting a virtual separation of the eyes of the spectator. The construction of this instrument, we may premise, is within the reach of every reader who possesses a modicum of mechanical ability, while its utility for purposes of observation is undoubted.

It consists of a light piece of tube of a moderate degree of width, say two inches, the length being considerably in excess of the distance the eyes are situated apart. That with which we have experimented exceeds six inches in length. In one side of this tube are cut two round apertures equidistant from the center, their diameters being a little under an inch; another pair of holes are cut on the opposite side of the tube, but one of each of them being situated as near to the end as possible, their diameters also being as large as the tube will admit of. If, while in this state, the eyes be directed to the eye-holes, nothing but the opposite interior of the tube would be seen; but, by means of a pair of small silvered glass mirrors placed at an angle of forty-five degrees directly opposite the holes, the eyes become cognizant of such scenes or objects as happen to be situated at right angles to each of them, causing a confused appearance by the blending of the dissimilar scenes. But by means of a small mirror placed in each end of the tube opposite the outer aperture in the side, and having its plane quite parallel to that of the eyepiece mirrors, the view of nature that is presented by looking into the eye apertures is precisely similar to what is seen by the unassisted eyes, subject, however, to this difference—that moderately near objects appear closer at hand, and distant objects more distant; in short, that the relative distances of objects from each other have become intensified or magnified. We have described the instrument in its simplest form, but it will be seen that by adopting a telescopic construction of the tube any desired degree of intensity or exaggeration may be imparted to the distances in the scene under examination.

Every photographer conversant with the use of the binocular camera knows that the wider apart the lenses are mounted on the camera the more pronounced will be the stereoscopic effect of the pictures taken under such conditions. There are certain subjects, however, which from their nature are not amenable to being taken with stereoscopic effect at all, unless under circumstances in which a departure from ordinary usage has taken place. Of this kind is the photographing of a coast line from the sea.

A few days ago it was our good fortune to be on board a quick-sailing yacht when, under a fair wind, she was making rapid progress within a mile of the coast of the island of Hoy, one of the Orkney group. To the eye the coast appeared uniformly even and monotonous, but from previous acquaintance with the scene we knew that this uniformity was only apparent, as the coast in reality was indented with creeks. To render apparent in a photograph these creeks with the accompanying headlands a stereoscopic camera seemed altogether inadequate; for, as no stereoscopic relief was visible to the eye, so neither would there be any in a binocular transcript of the scene. We therefore seized the opportunity of putting into practice something respecting which we have already thrown out a hint in these pages. Accordingly, having adapted to the camera a pair of quick-acting lenses fitted with shutters capable of rendering it easy to give an exposure the fractional part of a second, we placed an exceedingly-sensitive dry plate in the slide, directed the camera toward the coast, and exposed one half of the plate only. Having allowed the yacht to proceed several hundred yards, we exposed the second half. In accordance with the principle laid down in the former part of this article, the picture, when developed and examined in the stereoscope, showed ravines of great depth, the jutting headlands projecting forward with singular boldness, and the creeks retiring away inland. In short we obtained not merely a relief which was altogether invisible to the eye, but which could not under any other circumstances than those described have been rendered visible. The value of this method of acquiring a knowledge of the contour of an unknown coast must be apparent.

By making use of the highly-sensitive emulsions now so easily made, or of the plates so readily procured, no difficulty will be experienced in the practice of photography aboard ship. If a rapidly-acting shutter be employed it will be found that, even when the vessel is subjected to sensible motion other than that of the smooth, onward, gliding motion of progress, a picture may be obtained satisfying all the requirements of, at least, artistic sharpness. We do not now allude to the facility of taking groups or scenes *on board of* the same ship on the deck of which the camera is planted, because in this latter case a prolonged exposure may be given without jeopardizing the sharpness, seeing that both the subjects and the camera partake of the same kind of motion in common. The highly-sensitive gelatine plates, on the preparation of which such plain directions have recently appeared in the journal, will prove exceedingly useful for such flying shots as we have here indicated.—*British Journal of Photography.*

ON ACOUSTIC REPULSION.

By V Dvorak

[Translated from Annalen der Physik und Chemie, Band III., No. 3. Dated Agram, November 19, 1877. With a note by Alfred M Mayer.—*American Journal of Science and Arts.*]

(1.) *Acoustic repulsion of resonators which are open at one end only.*—In a previous article "On Acoustic Attraction and Repulsion," I have conclusively proved by theoretic considerations, as well as by experiments, that the average pressure at the node in a column of air vibrating in stationary waves cannot be equal to zero as long as the amplitude of vibration is not infinitely small.

In a resonator open at one end, as for example a cylinder, we find a node at the closed end. In the interior of the cylinder near its closed end there exists a greater pressure than on the outer surface of this end, which is touched by the outside air, as can be easily shown by means of a sensitive manometer.

To obtain resonance the opening of the cylinder is turned toward the source of the sound, and the cylinder is then repelled by the excess of pressure within. Resonators not having a cylindrical form, but open at one end, are also subject to such repulsion. In my previous communication I have indicated means for observing the acoustic repulsion of resonators. As the method described there is not very sensitive, I have replaced it by the following. The resonators here employed are usually made of stiff drawing paper covered with gum arabic and have the shape of the cylinder with a little paper tube, *h f*, at one end, Fig. 1, A. This little tube may also be omitted as in Fig. 1, B; in that case

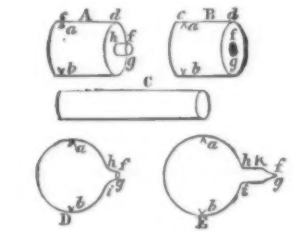


Fig. 1.

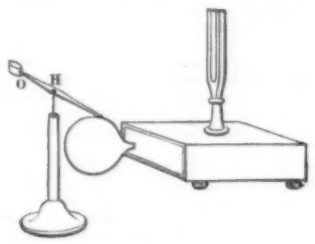


Fig. 2.

the resonator is tuned by increasing or diminishing the little opening, *f g*. Even a cylindrical tube open at one end, Fig. 1, C, may serve our purpose as a resonator. Spherical resonators of glass, Fig. 1, D, which a practiced glass blower can make as light as paper resonators, are excellent. The note of the resonators is determined by gently blowing over the opening or by tapping.

The resonator is fastened with sealing wax to the end of a light wooden rod, the other extremity of which is provided with a counterpoise of lead, O, Fig. 2. The center of the rod has a glass cap, H, which rests on a needle point.

The best source of sound is a resonant box of a tuning fork, Fig. 2. The repulsion is so great that it is apparent even with an ordinary brass Helmholtz resonator, weighing, with the lead counterpoise, 142 grammes.* With every tuning fork we must first ascertain whether the air in the resonating box vibrates with sufficient energy, because this is not always the case even with accurately tuned boxes. As the elasticity of the different boards which form the elastic system of the box is not equal, their vibrations may hinder the formation of the node at the bottom of the box; in this case the air on the bottom of the box will vibrate but feebly. We can easily ascertain this fact by accurately tuning the box to the note of the fork and then observing whether the note is considerably weakened by partially covering the opening. If it is not, then the air in the box has but little vibration even if the tone of the fork is powerful. I have, for example, two boxes with excellent tuning forks by König (of 256 vibrations per second), in which the air would in no wise vibrate powerfully. The strength of the vibration of the air was considerably affected by the degree of tightness with which the fork was screwed to the top of the box. The fork is always vibrated powerfully with a bow, and two bits of rubber tubing must be on the bottom of the box. I generally use the fork A_3, of 435 vibrations per second, by König. Repulsion is then plainly visible with glass resonator at a distance of ten centimeters from the opening of the box. With a large C fork of König (of 128 vibrations), which sounds for more than ten minutes, it was apparent at a distance of twenty centimeters.

The resonators may be tested either by the re-enforcement of the sound produced with a tuning fork, or by the weakening of the sound on approaching them to the opening of the box.* It is not possible to obtain the repulsion of resonators from the prongs of a tuning fork alone, as their aerial vibrations are too weak. (Compare Pogg, clvii., p. 42.) I formerly tried in vain to obtain acoustic repulsion from vibrating bodies without the aid of resonance. I suspended small resonators before the end of a glass tube vibrating longitudinally and provided with a cork to increase the vibrating surface. The open end of the resonator was probably too near the end of the fork, and so produced a lowering of the tone and acoustic attraction instead of repulsion. Attraction is probably present in all cases and can assert itself only when not counteracted by greater repulsion.† Later I obtained repulsion very easily in a longitudinally vibrating glass tube 127 centimeters long and 27 millimeters in diameter, on the end of which was a cork 46 millimeters in diameter. One of the resonators used was spherical, Fig. 1, B, and another cylindrical, C.

I also obtained powerful repulsion with a circular disk 31 centimeters in diameter and two millimeters thick, made by König. The plate was fastened in the center in a vertical position and made to vibrate in six segments, producing a note of 208 vibrations. The resonator was made of stiff paper of the form of B, Fig. 1; *a b* equal 80 millimeters, *c d* 140 millimeters, *f g* equal 17 millimeters, and its opening was placed in front of the center of a vibrating segment, or venter.

(2.) *The Acoustic Mill.*—A continuous rotation is easily obtained on the principle of the acoustic repulsion of resonators by fastening four very light paper or glass resonators upon two wooden rods, *o, p; r, q*, Fig. 3, crossing at right angles, and balanced on a glass cap; all the openings of the resonators fronting one side in the direction of tangents. The whole apparatus is placed before the opening, K, of the resonating box and fork, in the manner indicated in Fig. 3. The open end, *a*, of resonator 1 is repelled from K; the closed end, B, of resonator 2 is attracted, but in general this attraction does not increase the rapidity of rotation, because it counteracts rotation the moment the resonator 2 has changed its position about 45°. It is therefore not possible to obtain continuous rotation by means of acoustic attraction, as I have shown by numerous experiments.‡ The resonator 1 continues to move by reason of its inertia and resonator 2 takes its place, being in turn repelled, and so on.

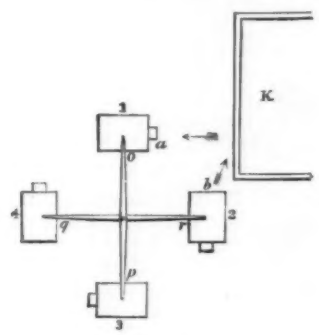


Fig. 3.

A very rapid rotation is obtained by using a large Kundt's tube and placing a small acoustic mill before its open end.

The glass tube (Kundt's), which vibrates longitudinally and produces the tone, is fastened to a heavy table, and protrudes only a short distance through the cork into the glass tube, placed upon a separate table so that its open end projects somewhat beyond the edge of the latter. The length of the rod was 127 centimeters, the diameter twenty-seven millimeters; the half wave length of its note, $\frac{\lambda}{2}$, equals ten and one-half centimeters. The length of the tube was 45 centimeters; the length of the vibrating column of air, corrected for the open end, was $3\frac{\lambda}{2} + \frac{\lambda}{4}$; the inner diameter was five centimeters.

(3.) *The Acoustic Torsion Balance.*—If we hang by a wire a wooden rod provided with a resonator, like the beam of a Coulomb's torsion-balance, in a case having an opening in the side turned toward the resonator, we can compare the intensity of notes having an equal number of vibrations by means of the repulsion of the resonator; but further experiments are necessary to test the practicability of this method. The sound proceeded from an open pipe, having the note A (of 435 vibrations). To prevent the current of air which passes through the pipe from striking the resonator attached to the balance, we must cut the pipe exactly in the middle of its node, and insert a slack membrane softened with glycerine. To prevent the air, issuing from the mouth of the pipe, from impinging on the resonator, a broad box is used which surrounds the mouth of the pipe air-tight. This box is open on the side opposite the resonator so as not to impair the tone. The pipe is sounded by means of a König's acoustic bellows with a uniform blast of air. The distance

* The apparatus represented in Fig. 3 may be also used to show acoustic attraction by turning the closed end of the resonator toward the box.

* This is perhaps connected with a conversion of the aerial vibrations in the box into the work of repulsion. The *vis viva* of the sound vibrations disappears to reappear as work.

† These experiments were also described in a previous communication. In the apparatus represented, Fig. 2, repulsion is easily converted into attraction by diminishing the opening of the resonator with wax, and so throwing it out of tune.

‡ Instead of the resonators, Fig. 3, I used vertical paper vanes, varying the curvature without achieving any results, notwithstanding the fact that there was a pretty strong acoustic attraction for each separate vane.

of the resonator from the mouth of the pipe must be at least two or three centimeters, to avoid a change of pitch.

(4.) *Production of Aerial Currents by Sound.*—It may easily be proved by simple theoretic considerations that the mean pressure at the node of a column of air is greater than at its venter, and that it steadily diminishes in passing from the node to the venter, provided that the amplitude of vibration is not infinitely small.

It would seem that this difference of pressure would be neutralized by the passage of the air from the node to the venter. There would then be produced a mean pressure in the whole column, which would be greater, however, than that of air at rest. Consequently air would issue from the opening of the vessel in which it forms stationary waves. I have not succeeded so far in making the whole process clear, for in reality no perfect balance of pressure takes place. The manometer always shows a slight excess of pressure even at the venter, but this excess increases as we pass to the node. All my previous experiments indicate moreover that a current of air passes from the node to the venters, at least in Kundt's tube, in which the air waves are very powerful. This *principal current* lasts as long as the air vibrates. Besides, the same experiments show a continuous secondary current, close to the walls of the tube and in a direction contrary to that of the principal current, so that the whole air in the tube is in circulation. The cross section of the principal current is nearly as great as that of the tube, while that of the secondary current is a very narrow ring.

The excess of pressure as shown by a manometer at the node is always less than the theoretical pressure, because in the latter the air is not supposed to move from the node and to equalize the pressure. Of course the excess of pressure at the venter is not equal to zero, as theory requires. Probably the friction of the walls has much to do with these phenomena. It may be expected from what has been said that the air will issue from the vessel in which it vibrates in stationary waves. The manometer shows in the first place that the excess of pressure is not equal to zero in the plane of the opening of a resonator because a portion of the air immediately in front of this opening partakes of this stationary wave motion, and because there is always a small excess of pressure even in the venter of a stationary wave. There is no doubt that a partial equalization of pressure takes place at the opening; experiments show, furthermore, that there is a continuous exit of air which, as in Kundt's tube, is probably neutralized by a secondary and contrary current.

The exit of the air can easily be proved, as follows: A spherical glass resonator is placed before the resonant base of a tuning fork, the resonator is filled with tobacco smoke, strong vibrations are given to the fork, when the smoke will be seen to rush from the resonator.

The current of air proceeding from a resonator is well shown by means of a Chladni plate, by means of lycopodium, which accumulates upon the venters in little heaps when the plate is sounded. If now we place the opening of a bottle or bottles of a resonator, B, over such a heap, the lycopodium is immediately blown about in a circle and may be scattered in any direction by giving suitable inclinations to the resonator. A glass plate held over a heap of lycopodium produces the opposite effect by causing it to contract.

I have succeeded in producing comparatively strong currents of air in still another manner, but I have not yet found an explanation of these complicated phenomena.

A cone made of stiff paper was held with its large end opposite the opening of a large Kundt's tube. The size of this cone may vary, but its effect is greatest when it vibrates to the same note as the Kundt's tube, and so forms a resonator open at both ends; the diameters of its open ends are thirty-seven and seven millimeters, and its length ninety millimeters.

When the Kundt's tube begins to sound loudly a current of air issues from the narrow end of the cone with such violence that it easily blows out the flame of a candle at a

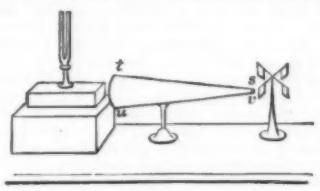


FIG. 4.

distance of twenty centimeters. This current rushes through the cone with a peculiar noise and is easily felt with the finger.

The cone may be replaced by a cylinder having the width of the Kundt's tube, open at the end turned toward the latter, and closed all but a small hole at the end, but the current is much weaker; nevertheless it will move a small wheel with vertical paper vanes, Fig. 4.

In the experiments with the tuning forks, it is essential that the cone should vibrate to the same note as the fork, otherwise the current is too weak. For the fork A (of 435 vibrations), the openings of the cone have diameters of 82 and 3 millimeters, and the length 373 millimeters. The opening at the apex of the cone must be very small to obtain an appreciable current.

On conclusion of this investigation, Dr. R. König kindly communicated to me that Mr. Alfred Mayer in New York [Hoboken] had previously succeeded in producing continuous rotation by means of sound. The communication was as follows: "Professor A. M. Mayer showed me a very similar experiment last summer (1876). He suspended by a thread two large well-tuned flasks attached to a rod, and caused the whole apparatus to revolve by means of a tuning fork. I informed him in consequence that you had previously demonstrated the phenomena of repulsion in resonators, for he was not acquainted with your paper* on acoustic attraction and repulsion."

NOTE BY PROFESSOR ALFRED M. MAYER.

My connection with the discovery of the Sound-Mill is as follows:

In January, 1876, I made the discovery—first reached by theoretic deductions—that there was more pressure on the inner surface of the bottom of a resounding cavity than on the outer surface of the bottom which touches the outer air. I subsequently proved the truth of this conclusion by experiments on suspended resonators, and by observations on the motions of precipitated silica powder and films of soap-bubbles placed at various points in resonators of different forms. My first publication of these results was on May 23d, 1876, on which day I read a paper on this discovery before the New York Academy of Sciences, and exhibited before the members an apparatus formed of two cross arms of light wood, with a resonator attached to each arm, as in Fig. 3 of Professor Dvorák's paper. On sounding an organ-pipe, or a fork on its resonant box, in tune with these resonators, they were successively repelled from the pipe, or fork, and a continuous rotation was exhibited. At the same meeting this experiment was preceded by those on the motions of silica powder, etc., in resonators.

On the 8th of July, 1876, there appeared in the SCIENTIFIC AMERICAN a report of this meeting of the Academy, in which my experiments in Acoustic Repulsion are thus referred to:

"In the next place, Professor Mayer exhibited an apparatus constructed by him to produce motion by means of sound pulses. Four glass resonators on cross arms were suspended by means of a string. On sounding an organ-pipe in tune with the resonators, and bringing it opposite the mouth of one of them, the resonator was repelled and the apparatus commenced to rotate. This experiment was the more striking from the fact that, so far from any current of air proceeding out of the mouth of the organ-pipe, the air is actually sucked in, as may be rendered visible by means of smoke from a cigar. The smoke is carried up the pipe even when the latter is closed at the top with cotton wool so as to smother the sound. On substituting disks of cardboard for the resonators, they were drawn up to the mouth of the organ-pipe with considerable force. When fine silica powder was placed in the resonators, it was thrown into violent motion on sounding the pipe."

In the same month, July, 1876, Dr. Rudolph König visited me, and I exhibited the same experiments before him.

The discovery of the acoustic repulsion of resonators and the invention of the sound-mill were made independently by Professor Dvorák and myself. It is another instance of men—even so far distant as Agram and Hoboken—led into the same path of research by the natural growth of science.

Dimensions of the resonators and reaction wheels used, in millimeters: (1.) Fork C, of 128 vibrations. Glass resonator of form E, Fig. 1, $a\,b$, equals 90; $h\,i$, 25; $h\,k$, 20; $k\,f$, 33; $f\,g$, 8. Its weight, together with its loaded counterpoise, was 70 grammes.

(2.) Fork A, 435 (vibrations per second). (*a.*) The glass resonator used in the experiment represented in Fig. 2, and to show the current of air by means of smoke, was of the form D, Fig. 1. $a\,b$ equaled 58; $h\,f$, 22; $f\,g$, 10. (*b.*) The glass resonators of the acoustic mill were of the form D. $a\,b$ equals 34; $h\,f$, 12; $f\,g$, 3. The length of the arms from the middle of the glass caps to the middle of the resonator was 52 millimeters. The weight of whole wheel was 23 grammes. (*c.*) Paper resonators of the acoustic mill, Fig. 3, were of the form A, Fig. 1. $a\,b$ equals 34; $c\,d$, 50; $h\,f$, 6; $f\,g$, 9 millimeters. The length of the arms was 65; the weight of the whole wheel 9 grammes.

(3.) Kundt's tube, $\frac{\lambda}{2}$ equals 105 millimeters. The glass resonators of the acoustic mill were of the form D, Fig. 1. $a\,b$ equals 24; $h\,f$, 2; $f\,g$, 7; length of the arms, 30 millimeters.

It is a striking fact that very small resonators may give a very deep note; with fork A, I used a glass resonator of the form D, Fig. 1, in which $a\,b$ equals 24; $h\,f$, 14; and $f\,g$ 1 millimeter. The volume was about ninety times less than that of the resonant box of the fork, to whose note the resonator was tuned. Notwithstanding its smallness it showed acoustic repulsion.

* Read before the R. Acad. Sci., Vienna, in 1875.

SCIENTIFIC PROGRESS.

THAT we live in an epoch of wonderful discoveries is a truism the truth of which is far too little appreciated. We have the thought as seldom in our minds as the phrase often on our lips. Human nature is ever prone to keep its eyes fixed on the low, level features of life, and each generation seems to be living in the most uninteresting and uneventful of ages. We are like the boor who at sunrise trudges over a lofty mountain top, and sees nothing but fields and hedges, cattle, and cottages, while to the gazer from a further range all these commonplace details are lost in a glow of light and color. For future ages it is reserved to know the worth of ours in its full glory and proportions. Only now and then, as we compare yesterday with to-day, some flash of insight reveals for a moment the true significance of what is going on around us in this dull nineteenth-century light; then, perhaps, we start and ask ourselves if it is a dream, or if to-morrow is indeed to owe more to our generation than to the work of a hundred half-forgotten centuries.

These are boastful words, but are we not justified in their use? Every age is, in a sense, an age of transition; yet, in scientific development, as in other forms of progress, there are pregnant epochs, spasms of conception and production, marked transcendings of the ordinary rule of growth. We have known the beginning of such an epoch, the end of which is not yet apparent. If discovery does not slacken its pace, but proceeds at a rate accelerated by multiplying means of information and comparison, the infant born to-day may live to look on the surroundings of our life as a strange form of barbarism. Scarcely any discovery can be imagined too astounding to be incredible, after all that has happened within one generation. There are men still living who can remember when the very name of Evolution, the governing idea of scientific thought, was scarcely known, when our now familiar laws of matter and force were mysteries to the profoundest philosopher, and when dreams and guesses were the only explanation of phenomena which are daily weighed, measured, and dissected by the veriest apprentice of science.

In electricity more than any other path of science is this progress evident. It is but half a century ago that to circle the earth in forty minutes became more than a poet's imagination. Since then improvements in the electric telegraph have come with something of its own speed, one following another almost before the public mind could realize the importance of what had been already superseded. It was only yesterday that we were laughing at the very notion of the telephone. To-day we are opening our eyes at the microphone, uncertain as yet what to think of its extraordinary phenomena. And, from sources that cannot be named here, comes information of experiments the result of which already give reason to expect that we are on the eve of a still more stupendous electrical discovery.

For us who handle these marvels day by day it is surely good to pause and reflect upon them, lest in our familiarity we forget how marvelous they are. The undevout astronomer, it has been said, is mad; and so must the head of the frivolous electrician be at fault as well as his heart. It is a grave mistake to think that hardness and narrowness of mind are necessarily produced by scientific studies. There are men, both learned and ignorant, to whom a "primrose by the river's brim" is a mere worthless yellow flower, or a mere member of such and such a class and order, and nothing more; but to one who has wisely studied nature, the humblest weed is a manifestation, no less wonderful than the thunder-storm or the rainbow, of the mighty forces pervading time and space. Science, indeed, opens out new and infinite fields for reverence to the mind of man, and, if he behold not, the fault is in his own blindness. To much has knowledge been distrusted in the past. A monopoly of the nobler intellectual qualities has been too commonly claimed by the complacent bigot who fondly takes his microscopic ideas for the center of all things, who announces that in his duck-pond of individual or sectarian opinion we must look for the boundless ocean of truth, and who, perhaps, professes to calculate to an hour and a day when this petty existence is to fall in ruins. But how much greater must be his awe and earnestness who has learned that our deepest thought and our loftiest imaginations only serve to reveal to us our own littleness, that the engrossing joys and sorrows of each one of us are but as a grain of sand amid the immeasurable energy through which we have our being; nay, that all our world's history, its thousand years of wrongs and glories, of loves and hates, of doing and suffering, its myriad millions of births and deaths, is naught but a pulse-beat in the eternal life of the universe.

Into what are usually called religious matters we, of course, do not enter, yet, surely, we may urge that our work is one to be done in a devout spirit. All the best work of the world has been done in such a spirit, and no such worker has lost his reward, however he may have seemed to miss it. It is useless to argue this point with the cynics who point to the inventive genius dying in obscure poverty, while the prosperity and audacity of the quack are recorded in a thousand advertisements. No words can hint to a mean nature the satisfaction of having done something to benefit one's fellow men, but to a great soul there is no richer prize. And what, if we work unknown, or if, as is the case with all but one in a thousand, our work be not to lead, but to follow and serve the leaders? Little or great, famous or unknown, should not matter to the true man; it is the how and not the how much that concerns him most:

> The noblest service comes from nameless hands,
> And the best servant does his work unseen.
> Who found the seeds of fire and made them shoot,
> Fed by his breath, in buds and flowers of flame?
> Who forged in roaring flames the ponderous stone
> And shaped the moulded metal to his need?
> Who gave the dragging car its rolling wheel,
> And tamed the steed that whirls its circlings round?
> All these have left their work and not their names;
> Why should I murmur at a fate like theirs?

Rightly looking to the end, we ought to forget our own glory and profit, and, considering what a cause and what instruments are ours, we should patiently and hopefully devote ourselves that through our labor life should be left to our children better and wiser than we found it. Thus is it in the hands of every electrician to help or hinder scientific progress.—*The Electrician.*

THE ELECTRIC FUSE AND HEAVY CANNON.

IT seems as if we were about to abandon the old method of firing guns on board ship with the lanyard, and to use the electric fuse instead, at any rate so far as heavy cannon are concerned. For some years past experiments have been carried on in the navy with electric firing, but it is only since we have had to do with very heavy guns, and particularly those in turrets, that this method of discharge has become almost indispensable. To be cooped inside a close iron turret in company with a pair of terrible weapons of 35 or 38 tons, and to experience the full measure of their thunder, is scarcely to be contemplated with indifference; yet this is not the reason, or at least not the principal reason, why the electric current is to be employed in the future instead of the gunner's arm. The real cause is twofold: in the first place it is possible to take better aim by using electricity to do the work; and, secondly, the effect of the shots are more terrible. The simultaneous discharge of three or four projectiles against heavy armor has been found capable of penetrating the latter, when single shots are quite unable to do so. A vibration is set up in the iron plating, it is presumed, and in this condition the armor is more vulnerable. Simultaneous firing is impossible by hand and word of command, in the same way as gunners used to fire broadsides in the old three-decker days. To the ear the thunder of discharge might appear instantaneous, but the effect upon an ironclad is vastly different if a volley is fired by lanyards, or by a flash of electricity. The other reason is more important still. The guns are so close to the water, and the portholes so limited in size, that sighting along the weapons is frequently a matter of difficulty. The operation is much more easily performed by an officer stationed above, either in the rigging or in the armored tower, with which most of our modern ironclads are fitted. Provided with suitable sights and electric wires which lead down into the batteries, the captain, or other officer of the ship, here has the whole of its armament under his hand. He directs at what angle the guns shall be laid, and watching his opportunity, discharges them simultaneously at the instant he thinks most fit. Situated above the deck he is removed from the bustle and smoke below, and can act with more coolness and judgment, while obviously no time is lost when the critical moment for firing arrives.—*London Standard.*

A NEW BATTERY.

THE *Correspondance Scientifique* gives the following description of a new form of battery which was brought to the notice of the Académie des Sciences, of Paris, at the session of July 1st, by M. du Moncel in behalf of the inventor, M. Pulvermacher. In the construction of this apparatus the inventor seems to have solved the question which has occupied the attention of electricians ever since the invention of the Bunsen battery—the discovery of *a continuous battery excited by a single fluid.* M. Pulvermacher is the inventor of an electrical chain in considerable use among physicians in the treatment of nervous disorders. For a long time he had remarked that one element of his chains worked better outside of the exciting liquid than when immersed in it. This was the hint which led him to institute a series of experiments which culminated in the production of a single fluid battery of great constancy, in which depolarization may be effected, not by physical and artificial oxidants, but by using a natural and inexhaustible agent—atmospheric air. M. Moncel explained the battery as follows:

The exciting fluid (dilute sulphuric acid, caustic potash, or sal ammoniac) is placed in a porous cylindrical cup; an

amalgamator rod of zinc immersed in the liquid constitutes the positive metal, while the negative is formed of a long helix of fine silver or platinum wire wound around the cylinder. The spirals of the silver wire are separated at such a distance that no capillary effects may be produced between them, and the wire thus comes in contact at an infinite number of points with the liquid which transudes from the porous cup. It is upon these numerous little surfaces of contact that the exterior air constantly exercises its oxidizing action, and thus effects depolarization.

For practical use the elements are united into battery form in such a way that all contact with moisture, and consequent loss of electricity, is avoided, and the apparatus charged and discharged by means of a simple device. By taking care to renew the exciting fluid and the zinc the apparatus may be used indefinitely, since the oxidizing agent renews itself.

The electro-motive force of the battery charged with caustic potash averages 1·5 *volts;* with sulphuric acid diluted to one-tenth it is 1·16 *volts.* To give an idea of the rapidity of depolarization, it is stated that in forming the circuit (of a resistance of 10 *ohms*) during ten minutes, the electro-motive force diminished about 16 per cent., and returned to its initial value three minutes after opening the circuit.

ENGLISH VERSUS AMERICAN FARMING.

IT has become a proverb that the farmer's life is the most independent of all vocations. This is especially true as regards the American farmer. The United States Government not only offers to give a man land for a farm, but protects him in holding it against whatsoever foe. The American farmer, too, always has a market for his surplus products. In this respect the American farmer is highly favored. The agriculturist who comes to this country from abroad finds advantages which never entered his dreams when at home. Here he alone can realize all the profits that may arise from his industry and tact. Compared with farming in England, for instance, the contrast is very broad and striking. We fancy that it does not occur to the average American farmer that the advantages he enjoys are not fully appreciated. The English farmer does not usually own the farm he works, but pays an annual rent for it of from six to ten dollars per acre. In addition to this rent he pays the rate of taxes, which cannot be stated exactly in the average, but it is large enough at all events, sometimes amounting to half the rent.

In England, wealth, especially land, is a leading feature. Hence we hear much about "landlord and tenant" in England. The large owners of land in that country have their estates divided into farms of convenient size, and leased, for a stipulated annual rent, to tenants, who are called farmers. These farms usually comprise 100 to 1,000 acres. The estates of some of the English nobility net twenty, forty, and in some instances even £100,000 sterling. This fact may seem a little odd to the American farmer who owns large tracts of land. In some parts of the United States, notably in California, there are farms or ranches comprising as much as 25,000 acres, but these are free from the characteristics of the land-owner or landlord, the farmer or tenant, and the laborer of England. A recent writer states that the amount of "annual tribute paid as rent" by the farmers of England to the landed aristocracy is $300,000,000.

The American farmer of the wheat-growing States, for instance, usually owns the land he tills, which he has purchased often at less than the usual annual rent of an English farm, and his taxes are merely nominal; yet there are people who are carried away with the idea that farming in the United States does not pay. Again, the English farmer cultivates old fields which have felt the pressure of the plow for centuries, while the American farmer opens a virgin soil, requiring, or at least receiving, in the new States, no manure for successive years. In the old States, let us say parenthetically, the American farmer is too apt to despoil his land without the least attempt at renewing its yielding power, and when he gets tired of it he packs up and goes to some new locality, perhaps to the valley of the Mississippi, where it is unnecessary to buy manure. "There is plenty of good land in America." This wearing out of American farms is a species of spoliation.

The great success which follows the efforts of the English farmer is a subject of consideration. Their farms yield more of wheat to the acre than do American farms. The averages of the great Western grain-growing States are considerably below those of localities in England. Perhaps this is one of the secrets of the success of English husbandry. But "the British laborer is the best living tool in the world." It is said American agriculture implies education and intelligence. In England a plowman always plows, a shepherd is always a shepherd.

English farmers are able to bear the burdens of heavy rents and taxes, and to live comfortably, and even accumulate property, because the laborers, who constitute the large majority of the people, do not receive a fair compensation for their labor, and because they and their families are kept in ignorance, poverty, and degradation. And this is, perhaps, one of the secrets of agricultural success in England. Were the English farmer, however, compelled to pay American prices for the labor on his farm for a term of five or six years, he would be utterly ruined. On the other hand, if American farmers were required to pay the rents or charges which English farmers annually meet, it is doubtful whether, even with English prices of labor, they would be able to find a profit at all times in their operations. Certainly they would not under the existing wasteful use of land and their exhaustive methods of culture. Generally speaking, when an American takes a new piece of land his only policy is to produce the greatest value of crops for the market with the least labor, and then at some convenient time he gives his attention to the more important phases of husbandry.

The English farmer himself is a substantial, self-reliant, and well-educated man. He knows how to hold the plow, he can use the hoe, and knows how to "boss" his laborers; yet he works not himself. In his family an English farmer lives in much the style of the wealthiest New England owners. Rotation of crops has characterized English farms for climatic reasons, but the best English farmers have of late years adapted their methods to the growing wants and improvements of the country. The great principle of English husbandry is often said to be, keep the land dry, clean, and rich. Tenant-right in England is the right which a tenant, who is leaving a farm, has to payment for his labor and expenses contributed to the crops of succeeding years. It is in the nature of compensation for the unexhausted improvements. The reason why leased lands in England are better tilled than others is that more capital is employed upon them. In England, as in the United States, every man is ambitious to own land and to add field to field. Land cannot be well cultivated without a liberal working capital, anywhere.

American prices of farm products are somewhat lower than those of England, but the cheapness of our lands should save us more than this difference in prices. While the English farmer is permanent in his habits, the American farmer is migratory—first in New England or New York, then in Ohio or Illinois, and next in Kansas or Minnesota. Our farmers do not remain long enough in one place to establish correct principles of agriculture, and there is also a great want of capital in American agriculture. The American is contriving always to economize his labor, to work more with his head than with his hands. In all farm implements the American is far in advance of the English farmer. Manual labor is much dearer in this country than in England; but the cost of keeping horses, for instance, is much cheaper. The agriculture of England is very simple—four crops in a regular rotation, and mainly in the same order; wheat, turnips, barley, and grass are the four watchwords at which the earth unlocks her treasures to the English farmer—wheat to furnish bread for the people, turnips to feed the sheep, barley to be malted for beer, and grass in meadow, pasture, and field for the cattle, which give supplies of beef and dairy products.—*Boston Cultivator.*

SUBSOIL PLOWING.

"WILL it pay," asks a reader, "to subsoil our cultivated fields, and if so, under what circumstances?" A good deal was said and written a few years ago about subsoil plowing, and some farmers practiced it to a considerable extent. Subsoil plows of various patterns were invented, and the dealers and newspaper writers urged their use with no small amount of argument. It was claimed that subsoiling would drain wet land and thus render it earlier and warmer, and at the same time suitable for a greater variety of plants, while the crops would be increased to a remarkable degree.

Horace Greeley and Prof. Mapes were firm advocates of subsoil plows, and they related some strong statements in their favor from their own personal experience and observation, but the practice of plowing cultivated lands, with subsoil plows, to the depth of a foot or more, has not as yet become very popular in this country.

Many people confound deep plowing with subsoiling, and, having tried the former and failed of obtaining satisfactory results, are ready to decry all forms of deep tillage. Deep plowing, by turning up and bringing to the surface a considerable quantity of soil never before brought to the action of heat and light, may and often does prove injurious to the crops immediately succeeding. But the injury done to the crops by such deep plowing is by no means uniform on all soils. In our own experience, in the cultivation of lands composed of loam or gravel or the two mingled, we have never discovered any injurious effects from turning the soil over to a greater depth than usual.

We have once or twice turned in a light coat of manure and have buried it so deeply that the crops planted failed to derive sufficient benefit during the early part of the summer to get well started in season to produce abundantly the same year, and in such cases the succeeding years have seldom appeared to make up for the first year's loss; but the difficulty seemed rather a deficiency of manure than an excess of plowing. We have dug underdrains through all parts of the farm, in loam clay, in muck and in gravel, and the subsoil to the depth of two or three feet has been indiscriminately mixed with the surface soil and spread over the land along the drains, and in no case has there appeared any indications of land or crop poisoning by such treatment. Hundreds of surface rocks of all sizes have been sunk in various portions of the farm by digging holes by their sides of sufficient size and depth for rolling them in; but never has the subsoil thus thrown up showed itself injurious to the succeeding crops, but on the contrary such deeply dug soil has usually produced a better growth than other parts of the field.

We have no hobby about deep plowing, but believe that the circumstances of each farmer and the character of his soil must guide him as to the depth of his furrows.

Thus far in the history of American agriculture it has seemed to the majority better to move on to new land, when the old has become exhausted, than attempt to improve the soil by a better system of tillage. Surface plows have consequently been in much better demand than subsoil plows.

The increased cost of the work is one serious objection to very deep plowing, whether the soil is inverted or merely stirred in its bed. One or two horses will plow ordinary soils from 4 to 6 inches deep with comparative ease and at a rapid rate, but double the team is required for an additional depth of three or four inches. Subsoil plows have generally been rigged to follow other plows when inverting the soil, thus requiring an extra team, or a change from one plow to the other at every "round." With such an increased expense, few ordinary farmers will be likely to fall very deeply in love with subsoil plows, especially when told by those who have used them that they will spoil their land.

Opinions vary as to the length of time subsoil plowing affects a soil, some contending that such plowing is beneficial for several years, while others claim that, after a single winter's freezing and thawing, the soil becomes as compact as before, and that, if subsoiling is useful at all, it should be repeated often.

Like most other questions, this is one which must be decided according to the circumstances in each case. We could never see how a heavy undrained clayey soil could be long benefited by a single stirring with a subsoil plow, for after the water covers it again it must, like other mortar, become very hard and compact as the moisture dries out.

Our own experience in the use of the subsoil plow has been upon loamy soils, which have generally been plowed time and again from four to six inches deep, the plow and the feet of the team generally finding the same road bed in the bottom of the furrows at each successive plowing. Every observing person must have noticed that, in such a soil, especially if somewhat stony, it is quite difficult to crowd a common plow down into the soil much below the line of previous plowings. In a soil free from all obstructions, the old recommendation to let the plow go down a half inch or an inch deeper at each plowing may be well enough, but in a soil like much of our own, and like thousands of acres of the cultivated lands in various parts of New England, it is not an easy matter to get the plow to go below that old mud bed, nor to dive down under those same little cobbles which have turned the plow from its natural course or depth at every previous operation since the surface was first brought under subjection by our grandfathers.

Nearly every acre we cultivate has been dug over by a man and iron bar following after the plow and taking out the stones as they come in sight or are loosened by the plow in passing them, but just under these furrows are thousands of small stones, many perhaps no larger than a man's fist, and yet large enough, firmly embedded as they are in the soil, to turn the plough from its course and prevent it from drawing what it would be capable of in a clear, unobstructed furrow. These little stones are greatly in the way of all after cultivation with harrow or horse hoe. To break up this crust formed by the treading of the teams, and to start up these small stones so that they can be picked up and carried off, we have found nothing equal to a steel subsoil plow. It may be drawn by an extra team when plowing sod, one plow following the other, or by the same team hitched to either plow alternately; but we have found it a better way to use the subsoil plow upon old ground, drawing it with the same team all the time, going round and round, or back and forth as in ordinary plowing. As the standard of the steel plow is thin, no furrow of any size is made at the surface, and the power required for pulling it through such a soil is but little more than for ordinary heavy surface plowing. We find three horses hitched abreast will subsoil an acre of common loamy or gravelly soil about as easily as they will turn the sward in furrows seven or eight inches deep by fourteen inches wide, and do the work in as short a time.

In subsoiling in this way the expense is not great, especially if it takes the place of once plowing in the ordinary way, as it often may, for such plowing fits the land admirably for the use of the Randal harrow or the common two-horse cultivator.

If, however, the land is to be used for an orchard, a garden, or for root crops, and one is not afraid of deep plowing, he may follow the subsoil with an ordinary plow, when he will find that it will sink into the soil as it never could before, and will bring to the surface many of the cobbles which the subsoil has loosened.

Such a use of subsoil plows we have found highly satisfactory and would like to extend their work over all the cultivated land of the farm, and are doing so as fast as practicable. A field once plowed in this way on such a soil never forgets the operation. When running furrows over a spot which has previously been subsoiled, the ordinary plow always drops an inch or two without any change of hitch, and the furrows are much more evenly turned and much less broken up by the irregular working of the plow.

We may not have fully answered the question, "Will subsoiling pay?" but we have given our experience and opinions in the matter. It pays us on all soils like what we have described, where the common plow is more or less obstructed by small cobble stones in the bottom of the furrows, and where this bottom has been beaten down almost as hard as a common road, by the repeated tramping of animals while drawing the plow at that same old depth.—*New England Farmer.*

THE BAG-NET VERSUS PARIS GREEN.

IT is very evident, from an article by the "Corresponding Secretary of the Long Island Entomologists' Society, U. S. A.," published in the *Science Gossip*, that the beautifully "ten-striped *Doryophora*"—otherwise known as the "potato beetle," or "bug"—has been hitherto needlessly hunted down and cruelly abused. It is quite plain, too, that the excessive numbers in which this hitherto ignorantly-supposed pest has made its appearance in the Atlantic States, during the months of May and June of the last few years, have been grossly exaggerated. Even large city dailies, like the *World* and *Herald*, of New York, have devoted column after column to the consideration of this pretty insect. Their articles, however, were of course sensational in character, and evidently written up from data furnished by farmers who were bent on getting "a corner on potatoes;" or, perhaps, from agriculturists who were silly enough to believe that the mere stripping of every leaf and twig from a potato plant would really do any harm. Now every one knows that a leafless plant is not a bit worse off than an animal without breathing apparatus; why, then, all this needless alarm? Surely the "Corresponding Secretary of the Long Island Entomologists' Society, U. S. A.," from long experience in sticking pins through cabinet specimens of insects, must be able to give a great deal of sound *practical* advice as to their habits; and does he not expressly "assure" his English readers "that to us who have now for some years been familiar with the *D. decemlineata* (potato bug) the alarm felt in the Old World lest this insect should visit its shores seems *verging on the ridiculous?*" *Verge* on the ridiculous? Certainly it does; it not only *verges* on, but *is* ridiculous! Why did not the "Secretary" (who says he is an Englishman) write just such a paper years ago to the people of this, his adopted country, and thereby spare them the mortification of exhibiting themselves, as they have done, to the world as very ridiculous persons? "Certainly," says the "Secretary." "I should advise no Englishman to import live specimens, and I should advise all farmers and gardeners to rid themselves of the presence of the beetle, as I should advise them to rid themselves of a crop of thistles." Precisely, and so should we, for the two cases are so strikingly similar. Did not the naturalist Bonet once remark, "It is not so easy as you imagine to distinguish a rose tree from a cat?" Why should lesser lights then endeavor to study out the subtle differences that distinguish the thistle from the potato bug? "We have had this beetle on Long Island in immense numbers for years," continues the "Secretary," "and I do not believe that any one has suffered from any appreciable loss through its depredations." A gentleman named Dean, who is evidently either one of those absurd persons that the "Secretary" is pleased to style an "alarmist," or else an individual troubled with some mental hallucination which leads him to observe things in a different light from the "C. S. L. I. E. Society, U. S. A.," thus writes to Prof. C. V. Riley: "The beach (Coney Island) for miles was covered with them—the hummocks and sand-hills which compose the island were literally alive with them. In the towns of Flatbush and Gravesend the ravages of this insect *have been very serious.* The egg-plant seems to have afforded its favorite article of diet. I am puzzled that so many millions of them * * * steer for the barren acres of Long Island, on which the principal vegetation is a coarse sea-grass which they do not seem to touch. They *appear to have an irresistible tendency to travel East, and are only stopped by the Atlantic Ocean.*" Of course! These sagacious bugs are straining their longing eyes Englandward, evidently instinctively aware that a native thereof is actively engaged in spreading "a little oil on the waters" (as he terms it) to make their reception as free as possible from hostility—and *Paris green.* For be it known, the "Secretary" is "down on" Paris green. "If any loss has been sustained," says he, "it has rather been through the remedy used than through the disease. And here let me advise my countrymen, if the beetle should make its appearance in the tight little island, to *use no Paris green,* or other poisons, with a view to its extermination." There are two reasons, he states, why such a remedy should not be used: "1. Its application in any form is not without danger. 2. Its use is entirely unnecessary." To these we might add a third—*it is cruel;* for, when the poison is applied, the animals writhe as if in

great pain. Now the "Secretary" proposes a better method; he says: "For small plots of land hand-picking by boys and girls is efficacious and without danger; for larger lots an ordinary butterfly bag-net (!) swept gently along the potato-tops will capture more beetles in an hour than Paris green will kill in a week." Here, then, as will be at once seen by those who have had experience with the potato-bug, is a method that is not only humane, but eminently practical too. For while every beetle will thus be inevitably captured, the five or six hundred *larvæ* which each beetle produces will be left quietly feeding till, having attained beetlehood, they too shall fall an easy prey to the "bag-net." How much more practical and humane it is (and Mr. Bergh will thank us for this suggestion) to catch the bird by the "saline method" than it is to shoot it. Somehow or other, the "C. S. L. I. E. Society, U. S. A." seems as inimical to Paris green as the latter is to the potato-bug; and so, again, he says: "Recollect that Paris green will kill other things besides potato-beetles; an American farmer applied a pretty good dose of this poison to the potatoes in his garden 'one dewy eve,' and on the next morning found four dead milch cows in his pasture. The cows had broken into the garden, and—increased the quantity of beef in that vicinity." Here we are obliged to take issue with the "Secretary;" for, in this case, we can blame neither the Paris green nor the cows, but rather the unthrifty as well as careless "American farmer," who placed such slight barriers between his pasture and his garden.

"Mr. Rye tells you," says our author, "that Paris green is a favorite remedy here, but he does not understand the American mode of doing things. Some State Entomologist or other probably had a friend in the oil and color business, and gave a friendly puff to Paris green. Then the oil-and-color man advertises in some agricultural papers that he has the 'never-failing exterminator' of potato-bugs—Paris green—and the editor of that journal at once *strongly* recommends it. You do not do things in that way in honest old England, but we do here." Now this is a little bit too much—it is, to say the least, excessively impertinent; and we will, therefore, say just what we mean. We know of but one or two "State Entomologists," and one of these is Prof. C. V. Riley, a gentleman and a scholar—a *practical* entomologist, and one who has written, and knows, more about the potato-beetle than any person in the country. Prof. Riley recommends Paris green as the most efficacious remedy against this insect pest, and has given good sound reasons why the use of the article, with ordinary precautions, is perfectly harmless. If our English friends wish their island overrun with the potato-bug, should it chance to reach their shores, they would better heed the butterfly-bag-net advice of their compatriot, the "Corresponding Secretary of the Long Island Entomologists' Society, U. S. A.;" if, on the contrary, they wish to make short work of it, they would better read the writings of Prof. Riley and follow his directions. The latter gentleman is as much above recommending any article through motives of self-interest as the former conceited person is of receiving information. It is, perhaps, Prof. Riley's misfortune that his practical entomological knowledge has been gained in much more extended fields than those embraced by "Long Island's sea-girt shores," but then this very misfortune has worked to his advantage in making his fame world-wide. The late Commissioner of Agriculture, Mr. Watts, who will long be remembered by the scientific world for his remarkable Zodiacal Theory of Vegetation, would have remarked of such a person as the "C. S. L. I. E. Society, U. S. A.," that he gives evidence of never having gone beyond the scope of "the routine operations of a mere closet entomologist," and that "these are practically unimportant." To such a statement, notwithstanding the source, we could have taken no exception. We can only recommend this "Secretary," who don't seem to like "the way we do things here," to remember the proverb about the cobbler, and "not go beyond his last"—and of course, in this connection, by "last" we mean his *last* absurd article in the *Science Gossip*.

QUINCES.

Is it not a little singular that, amid all the enthusiasm concerning fruit and fruit culture, the culture of the quince comes in for so small a share? How shall it be accounted for? Is it because there is an insufficient market demand? If we read the market reports rightly we find that they net the producer from $3 to $5 per bushel in the principal markets, as New York and Boston. The quince, although a native of the south of Europe, has become a naturalized shrub and fruit of the United States, and might be made a source of no inconsiderable income by a judicious system of culture. In its native home it is cultivated as a shrub or small tree. As a small tree it is ornamental, even though its outline is less regular than the prim Norway spruce and Arbor vitæ. Its foliage, beautiful pink and white blossoms, and in autumn its branches pendent with golden yellow fruit, render it at once an object of special beauty and value, Practical housekeepers are too well posted on the uses to which this too much neglected fruit may be put to need any specific directions from my pen; it may be cooked in a variety of ways and form an acceptable, welcome dish, and, when thoroughly ripened, eaten raw they are very agreeable to the taste of many, and would be to more were the taste cultivated as for eating tomatoes.

The quince gives us but a small list of varieties, and only one or two of these are worthy of general culture for their fruit—others more for ornament. At the head of fruit varieties I would place the orange or apple quince. This is really the best quince if not the only one worthy of culture for economy in production and cooking purposes; it cooks more tender than other varieties. The pear quince, which is grown to some extent, is very tough and hard, very unlike the orange when cooked, but as it ripens later in autumn, it is better adapted to distant marketing or later keeping.

PROPAGATION.

The quince is propagated from seed, from cuttings, and by layers, the last two ways being preferable. When grown from seed they are seldom as good as the parent. The better way, where one desires to put out an orchard, or even a single tree, is to purchase from reliable nurserymen, as they can be obtained from a shilling to twenty-five cents each, so that the expense of an orchard is small, and two years or more time is gained.

SOIL AND PLANTING.

It is a very common practice to plant the quince "bush" where we would never think of setting any other fruit tree, and this fact may account for their seeming unprofitableness and their high price in market. The quince is as partial to a good, rich soil, well drained, as any other fruit tree, and will be found to as well repay good culture as other fruits and crops. A good, strong soil, suitable for growing good, sound corn, suits the quince. Usually it will endure as severe winters and cold as the average of apple trees, and may be planted with similar exposure or protection. One thing is very certain, that, although they seemingly like moisture, they will not thrive long in a wet soil. They may do well for a few years in such, but they are soon winter-killed, from wet feet.

In planting an orchard, trees set 14x14 feet is sufficiently near—some say 10x12—but I think that little is gained while more may be lost by near planting; they should be kept well fertilized. Feed them if you would have fruit in abundance. Top-dress the ground annually with muck, manure, bone-dust, salt or ashes, or all composted. Cut off the ends of limbs promptly if affected with blight of any kind; search for and destroy all borers, and use approved preventives of these depredators. By following these few simple directions you may have an annual crop of quinces which will supply you with funds to pay taxes and make "hard times" easy.—W. H. W., *in N. E. Farmer.*

AUSTRALIA—ITS DESERT, AND NATURAL HISTORY.

IN the second number, for the current year, of the American Geographical Society's Bulletin (just distributed) we find, among other matters of interest, a very readable account of a recent journey of exploration across the continent of Australia by Mr. Jess Young, the astronomer of the last party of exploration, known as the "Giles Expedition."

Australia (or New Holland, as it was formerly called) is, as the author reminds us, the largest island in the world, having a superficial area of 2,975,000 square miles, a very little less than the whole of Europe, its greatest length being 2,536 miles, and its greatest breadth 1,585. The first authentic record that we have of the country is a map by the Portuguese of an expedition under Heredia in 1601. It remained, however, unexplored and virtually unsettled by civilized man until the present century, when the efforts of the British Government and the discovery of gold combined to cause a rush to its shores; and then villages, towns and cities were rapidly built and populated. A variety of causes have hitherto prevented much being known about one of the most civilized quarters of the globe. Australia possesses none of those vast mountain chains, lofty peaks or mighty rivers which Americans are accustomed to see; the enormous expanse of country is almost entirely level, and geologists have been greatly puzzled over its formation. There are many indications that it was once the bed of an ocean. It is for the most part composed of primary rock, which forms the bed of the table-land; and this is pierced and rent occasionally by other igneous rocks of trappean formation, which are sometimes heaped up into mountains, or form ridges of rounding contour, but of little height. Rocks of secondary age, notably the carboniferous, prevail on the coast; and the plains of the western interior are tertiaries and recent sedimentary deposits. On the north coast the principal formation is a hard, ferruginous sandstone. The present conformation of the territory points to a volcanic origin, though no evidence of recent action is visible.

The interior of this immense island was, until within a few years, as a sealed book; and even now the knowledge concerning it is far from being general. It is known that vast deserts exist, wholly without water; the general aridity and absence of rivers being due to the absence of mountain chains. In the center and west there are a great many salt marshes and lagoons, and in the east a few rivers which alternately expose their dried beds to the baking rays of the sun or overflow their banks. Long and severe droughts oftentimes prevail. In 1865 there was no rainfall in Central and South Australia, and as a consequence sheep and cattle died by thousands every day.

Australia is divided into five colonies: *Western Australia*, the largest, has an area of 978,000 square miles; *South Australia*, including what was formerly North Australia—a fact not mentioned in school geographies—has an area of 906,828 square miles; *Queensland*, the next in size, consists of 678,000 square miles; *New South Wales*, with an area of 333,437 square miles; and lastly, though not least in importance, *Victoria*, whose area is 86,831 miles. The latter is the richest, most prosperous and most thickly settled of the colonies, a fact due to the gold discoveries of 1851, which in 1852 amounted to $70,000,000. The precious metal is found generally in quartz, granite and porphyry. By late statistics New South Wales appears to be in a fair way of wresting Victoria's laurels from her. These two colonies are the largest producers of gold, though each of the others add something to the enormous general yield. South Australia is noted for its copper, the Momta, Wallaroo and Burra-Burra mines being widely celebrated. Lead, iron, tin, manganese and quicksilver are also found, the iron being widely distributed.

To the botanist Australia presents a wide and varied field. Almost all tropical plants and trees grow here. Here are found trees that cast their bark instead of their leaves, lilies that grow high in the air, and ferns which grow as big as trees. The Eucalyptus trees (*Eucalyptus globulus*) are of enormous growth (350 to 400 feet high), and one specimen in the Warragong range, lying on the ground, measures 420 feet in length. There are casuarinas, acacias, banksias and hakeas, while species of leguminosæ predominate; and there are endless species of ferns. A peculiarity about the trees is that they begin to die at the top and thence downward, and that they usually cast their bark instead of their leaves. There is an absence of edible fruits, except a few berries and a few small indigenous peaches. There are several poisonous plants, which deal destruction among cattle and sheep. The grass-tree (*Xanthorrhea*) also flourishes, and is very common; these trees are called "black boys" in Western Australia, because they look so much like the natives. Once, while watching for a surprise at dusk from natives, the author fired at one of these trees, heard the ball strike, and was alarmed not to see his apparently invulnerable victim fall! A sort of scrub called mallee (a species of Eucalyptus) covers fully one-fifth of the whole colony, and makes traveling exceedingly monotonous. For days, weeks and months we may be in it without seeing twenty yards in any direction. It is in this scrub that so many lives have been lost from time to time. In one portion of the country there is a grass called the spinifex (*triodia*) which is the terror of men and animals. It grows in tufts from four to six feet in circumference, and about three feet in height; in appearance very like the yucca or soap weed of the western part of America. It is as sharp as the finest needle, and the author states that he has yet the liveliest recollection of having been thrown from his camel and landing in a sitting posture on an unusually fine specimen, and was obliged for days afterward to forego the saddle and to eat all his meals standing. There are two kinds of the grass, one growing in moderately good farming country, and the other in the horrible mallee scrub. The young shoots are eaten when young, but are worthless when old, unless some ingenious person shall one day utilize them for making paper.

The zoology of this immense tract of land is peculiar and interesting. It is distinguished by the great majority of marsupial or pouched animals, of which there are now few traces in any other part of the world. With the exception of one family (opossum) found in America, these animals are all confined to Australia and the islands immediately adjacent; and it is a singular fact, too, that *all* the mammals of Australia, over a hundred species of which are known, belong to this order. Fossil remains found in England and France indicate that they existed there at a very early period, when other animals of this age were in their infancy. It is supposed by many naturalists that all existing mammals originated from marsupials.

The kangaroo affords sport and food for the natives. There are numerous species of this animal, and some specimens weigh more than 200 pounds. Kangaroo-tail soup is considered a very excellent dish. Water and some beaver rats are peculiar to Australia. In the lakes and rivers of the north are found the crocodile, dugong, and turtle. In New South Wales, the wallaby, the bandicoot, the wombat, and opossum make their home; here is also found the native bear, which is nothing like the terrible beast of Western America, but a poor diminutive harmless brute with scarcely energy enough to move. Australia, too, is the home of those strange animals, the duckbills (*ornithorhynchus*)—half bird, half mammal.

Birds in Australia are numerous. The emu is the largest, and resembles an ostrich somewhat. There are swans (both black and white), pelicans, geese, eagles, hawks, quails, pigeons, cranes, herons, and the elegant native companions, parrots and parroquets, in abundance. One of the peculiar birds is the lowan—it is a native pheasant. It builds a nest in the sand, constructing the bottom of dried leaves and small sticks. Upon this is laid a thin layer of sand, and the whole is covered up with small gravel and sand. Each morning the bird deposits an egg with the small end downward, almost in the center of the nest, and covers it up again. This goes on until seven or eight eggs have been laid. The nest is now about twelve feet in diameter and three feet high; and she then covers it with an additional layer of sand, and leaves the eggs to be hatched by the heat of the sun. It has always been a mystery to persons of an inquiring mind how the young birds get out of the nest. The lowan is only about the size of an English hen pheasant, but the eggs are as large as those of a goose. The shells are so thin that it is unsafe to boil two in a pot together, or even one unless it is carefully wrapped in cloth. The general method of cooking is to stand them on end near the fire to roast.

The fish are whales, seals, sharks, codfish, snappers, mullet, and a host of others not found in any other part of the world.

The reptiles are really beautiful—crocodiles in the north, and snakes, lizards, scorpions and centipedes in the south. The iguana, a scaly lizard-like reptile, attains a length of four to five feet, and its flesh is esteemed a great delicacy.

Insects are wonderfully prolific, mosquitoes and flies being particularly abundant. The native children are sometimes hardly recognizable, so completely are they covered with flies, filling their eyes, noses and mouths. When eating, it requires dexterous maneuvering to get a piece of meat into one's mouth without its complement of flies. On the river and creek bottoms it is essential to wear a fly-netting constantly about the head. Spiders are very common, as are also ants; the tarantula being the most formidable of the former, and the bull-dog ant the worst species of the latter. These ants are an inch or more in height, and about two inches long. They all fight fiercely, and their sting is not at all desirable. They catch hold of one's skin with their nippers, bend the body under like a scorpion and put the sting gently in, leaving the venom, and sometimes the sting itself, in the wound.

As to the natives, the author believes that they are a maligned and misunderstood race. They have been generally described as depraved, degraded Cannibals, torturing their victims with the utmost cruelty. Such accusations are false in the extreme. Many tribes are already extinct, and in the course of another century or so an Australian black will be looked upon as an individual of a bygone age; for (as in America) as the white man advances in search of new pastures for his herds, he drives the native back from his hunting grounds.

Though many writers declare these people are Cannibals, and go so far as to describe the whole process of cooking their victims, the author states that he never found any trace of such habits as either torture, scalping or cannibalism; any native whom he asked having scouted the idea with disgust. Writers have always had to deal with natives on the coast and on rivers, where there are found much finer and much better fed specimens of humanity. Those living inland are smaller, thinner and dirtier, but are never bloodthirsty. They are treacherous, as are all uncivilized races. They have no religion, though they believe the soul is immortal, and that the dead sometimes return in another shape; for this reason they carry him round and round the grave at some distance, in order to puzzle the dead man as to his whereabouts.

Many expeditions have been undertaken with a view of exploring the western half of Australia, but all have met with disaster. Much has been done within the past four or five years to make known the character of this vast region, but it is only recently that we have had any idea of its geography, and this has been obtained hurriedly, since every expedition has been simply a wild race for life across the sands. The facts obtained indicate that the Central Waste is bordered on all sides by a belt, the greater portion of which is suitable for raising cattle and sheep. There are in the middle half a million square miles, which offer nothing but barrenness and death to the invader. Of this, the southern part is dotted with hills of soft, white sand, clad with spinifex, scrub oak and other shrubs, and an occasional group of eucalyptus; the northern part is destitute of even this useless vegetation, and its barren sand hills have not even spinifex to relieve their glare. There are well informed persons who believe that, despite their terrible nature, these lands will be brought under the control of man. It is said that dense forests are increasing upon the continent, and that the climate is becoming moister and more healthful from year to year, and that the country is gradually ceasing to become suitable for sheep farming and more favorable to agriculture.

A thorough knowledge of the waste can only be obtained by a series of experiments and observations conducted systematically by geologists and meteorologists at stations erected upon the few oases.

CHEMICAL NEWS NOTICES.

Fixation of Carbonic and other Acids.—O. Friedel and J. M. Crafts.—The syntheses which the authors have effected have their analogues in the reactions of sodium-ethyl and of zinc-methyl, and seem difficult to understand without admitting the formation of an organo-metallic combination of aluminum by the reaction of this metal upon the hydrocarbides. On passing a current of carbonic acid, dried by traversing tubes filled with pumice moistened with sulphuric acid and with phosphoric anhydride, into benzol mixed with aluminum chloride, and kept at a heat near its boiling point, a small quantity of hydrochloric acid is evolved. After a considerable time, which may amount to several days, the process is arrested and the mixture treated with water. The upper layer is decanted, and, after having filtered the watery stratum through a moistened filter, a small quantity of sulphuric acid is added, and the whole is moistened with ether. The ether, after being decanted and distilled, leaves a crystallizable body, which is benzoic acid.

Cast Manganese.—P. Jordan.—The author presented to the Academy a specimen of cast metal obtained by treating ores of manganese in the blast furnace. Its composition is:

Manganese	84·960
Iron	8·550
Carbon	5·700
Silicon	0·660
Sulphur	0·035
Phosphorus	0·005
	99·910

In subsequent operations the percentage of manganese has been carried as high as 87·4. The specimen laid before the Academy has been preserved for six months without having undergone any sensible alteration. There is a considerable loss of manganese in the furnace, amounting sometimes to 10 per cent, which, with certain other facts, seem to argue in favor of the volatility of this metal at elevated temperatures.

Volumetric Determination of Arsenic.—MM. A. Millot and Maguenne.—The form in which arsenic, when isolated, is most often determined, is the ammoniaco-magnesian arsenate. The precipitation is rarely complete even in presence of a great excess of magnesia; and the authors have often observed that in the filtrate, after concentration and acidification, hydrosulphuric acid produces a slight yellow turbidity of arsenic sulphide. Further, the precipitate cannot be ignited, but must be weighed with its filter. They propose as a substitute a volumetric process already in use for phosphoric acid. It is known that, in a neutral or slightly acid liquid, arsenic acid is completely precipitated at the boiling point by uranium acetate. If reagent is added drop by drop it becomes apparent when the precipitation is complete by the brown tint which a drop of the liquid takes when brought in contact with a drop of potassium ferrocyanide placed upon a porcelain plate. If the uranium solution has been standardized with a known volume of pure arsenic acid, the quantity of arsenic in the liquid is easily calculated. On account of the high equivalent of arsenic acid it is necessary to employ a solution of uranium more dilute than for phosphoric acid, 20 grms. acetate of uranium per liter being a suitable strength. Each c.c. of such a solution precipitates about 5 mgrms. of arsenic acid. The solutions of sodium acetate and of ferrocyanide are of the same strength as those employed for phosphoric acid. The ferrocyanide should have been prepared recently. The process requires that the arsenic acid should be completely separated from all the bases with which it may form compounds insoluble in weak acetic acid. This end is easily attained by decomposing, with pure fuming nitric acid, the arseniureted hydrogen which the substances produce in Marsh's apparatus. After two hours the volatilization of the arsenic is generally complete, as may be ascertained by igniting the gas escaping from the apparatus. The liquid which contains all the arsenic at the maximum stage of oxidation is then separated to dryness, redissolved, mixed with 10 c.c. of acetate of soda, and titrated with uranium. If the arsenic is mixed with antimony the latter is deposited during the evaporation, and does not interfere with the subsequent process.

* *Method of Separating and Determining the Stearic and Oleic Acids derived from the Saponification of Tallow.*—J. David.—This method is based on the novel fact that if acetic acid is dropped into an alcoholic solution of oleic acid a moment arrives when the oleic acid suddenly separates. Thus, if at a temperature of 15° 1 c.c. of oleic acid is dissolved in 3 c.c. of alcohol at 95 per cent, and if into this liquor there is dropped a mixture of equal volumes of water and of glacial acetic acid, the separation of the oleic acid—which does not even begin on the addition of 2·2 c.c. of the acetic acid—is completed by 2·3 c.c.; *i. e.*, a difference of $\frac{1}{10}$. It is not the same with the alcoholic solution of stearic acid, which begins to precipitate on the addition of the first drop. Further, stearic acid, which is insoluble in the mixture of alcohol and acetic acid, is equally insoluble when the mixture contains oleic acid. The authors effect the separation of the two fatty acids as follows: They mix in a flask a liter of glacial acetic acid with a liter of water. Operating at 15°, they pour into a small tube graduated in tenths 1 c.c. of pure oleic acid, then 3 c.c. of alcohol at 95 per cent, and finally 2·2 c.c. of the acetic acid. So far nothing ought to be precipitated, but if, on adding one-tenth c.c. of acetic acid, a turbidity appears, and if above the mixture of alcohol and acetic acid there floats 1 c.c. of oleic acid, it may be inferred that the sample is good. If not, the proportions are varied until the point of precipitation is hit within 0·1 c.c. of acetic acid. When this end is attained, alcohol and acetic acid are mixed in the proportions indicated by the preliminary trial—for instance, 300 of alcohol to 220 of acid. In the meantime they add to the alcoholic-acetic mixture 1 grm. or 2 grms. of pure stearic acid cut in fragments, and, finally, the lower end of the exit tube of the washing bottle is fitted with a small piece of sponge, so that when operating they may always have a clear liquid, free from undissolved stearic acid. When not in use both apertures of the washing bottle are kept well stoppered, in order to prevent the evaporation of the alcohol. The analysis is then performed as follows: 0·95 (grm. ?) of the fatty acid to be analyzed is weighed into a thin tube-flask, fitted with a well ground stopper. Upon it are poured 15 c.c. of the alcoholic mixture; it is repeatedly shaken up, and left for twenty-four hours in a cellar of the maximum temperature of 15°. The oleic acid being then entirely dissolved, the whole is thrown upon a small filter, in a funnel whose edges are ground and covered with a glass plate. The stearin remaining upon the filter is washed with the same mixture of alcohol and ether with which the filter is filled three times in succession, thus rendering it perfectly free from oleic acid. The stearic acid is then entirely washed from the filter into a tared platinum capsule by means of a stream of cold water from a washing bottle with a very slender orifice. The capsule is then heated in the water bath, and when the stearic acid has collected on the surface of the water, as an oily cake, it is allowed to cool. The water beneath this solid matter is decanted off, and the stearic acid is completely dried at 100°, or better in a vacuum. It is then weighed, and the weight, less that of the empty capsule, gives the proportion of stearic acid in 95 of the fatty acid.

Dissociation of the Salts of Aniline.—M. Goppelsroeder.—The salts of aniline, toluidin, and naphthylamin are decomposed into acid and base so completely by water that such salts in an aqueous solution may be advantageously titrated with a normal solution of potassa. The aqueous solution of these salts behaves like the solution of the free acid in the salts. The author announced at the same time that on passing a galvanic current through a hot and concentrated solution of a salt of aniline, he had obtained at the positive pole a pure green deposit which appeared to be emeraldin. This deposit turns black on oxidation.—*Bulletin de la Soc. Ind. de Mulhouse.*

Discharge on Vat Blues.—M. Oscar Scheurer.—Minium, or lead sesquioxide, if printed on cloth which is dyed blue in the vat, and then passed through cold and weak hydrochloric acid, gives very clear and well defined whites. If the passage through the acid takes one minute, a strength of $\frac{1}{4}$ degree B. (?), or 25 c.c. of the commercial acid to a liter of water, suffices for the production of a pure white. The cloth is then passed through boiling water to remove the lead chloride formed. If with the minium are mixed other insoluble colors, such as terra di sienna, ocher, chrome yellow, Guignet's green, etc., thickened with albumen, a variety of discharge colors are obtained. But it is requisite to steam before the passage through acid in order to coagulate the albumen. The defect of this procedure is the impossibility of entirely removing the lead chloride.—*Bull. de la Soc. Ind. de Mulhouse.*

Simultaneous Action of Ferricyanide of Potassium and certain Acetates upon Indigo.—M. Alb. Scheurer.—If a swatch of vat blue cloth upon which a design has been printed with potassium ferricyanide mixed with any acid is steamed, the indigo is destroyed. The destruction of the color is directly as the power of the base whose acetate is used, and inversely as the energy with which the same base retains the acetic acid at the temperature of 100°.

Fermentation of Dextrin.—M. Barfoed.—A solution of pure dextrin may enter into alcoholic fermentation under the influence of yeast alone, though the fermentation progresses much more slowly than with sugar. The gas disengaged consists exclusively of carbonic acid, other products of fermentation not being formed in appreciable quantity. There is no proof that the dextrin is previously transformed into glucose.

Molybdic Acid Reagent.—M. O. Maschke.—If calcium molybdate is moistened with a quantity of dilute hydrochloric acid sufficient to produce a clear solution on the application of a gentle heat, a deep blue coloration quickly appears in the liquid. In place of calcium molybdate those of ammonium, sodium, or potassium may be used, adding so much hydrochloric acid that the liquid if poured upon a plate of polished marble may produce a visible but very slight effervescence. If after cooling a concentrated solution of sodium or calcium chloride is poured into the liquid there is formed a blue-black precipitate, not easily distinguished in the liquid, and which may be regarded as a compound of molybdic acid and molybdic oxide. It dissolves with great ease, not merely in water but also in alcohol, and produces a coloration of extraordinary intensity. The author prepares the solution as follows: 3 grms. calcium molybdate, 250 c.c. of water, and enough of hydrochloric acid to effect the solution of 2 grms. of cane or grape sugar. When the deep blue coloration is apparent the ebullition is continued for five minutes. When the precipitate has been produced with sodium or calcium chloride, it is washed upon the filter first with the precipitant and then with a little water. As soon as the liquid begins to run through of a deep blue color, the filter with its contents is placed in distilled water and the solution finally made up to 250 c.c. This blue solution is decolorized with extreme ease by caustic alkalies and oxidizing agents, such as chlorine, nitrous acid, hydrogen peroxide, and permanganic acid. Hydrochloric acid of sp. gr. 1·24 produces in this solution a blue precipitate, the supernatant liquid being colorless. Sulphuric acid of sp. gr. 1·840 does not give a precipitate, but the color of the liquid is altered. Nitric acid of sp. gr. 1·185 produces a rapid decoloration. Dilute solutions of ferric salts decolorize, and those of ferrous salts occasion turbidity. The author has endeavored to employ the blue solution to detect nitrous acid in spring waters. The water under examination is mixed with a little caustic soda; after filtration, so much acetic acid is added that the liquid may have but a very feeble acid reaction. A test tube is three-fourths filled with this liquid, and about 6 to 10 drops of dilute acetic acid and 1 to 2 drops of the blue molybdic solution are added, so that, in placing the tube upon a white surface and viewing it longitudinally, only a very slight blue coloration may be perceived. Water containing only some tenths of a milligrm. of nitrous acid per liter will certainly destroy the color in an hour. The rapidity and distinctness of the reaction are remarkably increased on heating the liquid mixture gently for a short time. Solutions of potassium nitrate, containing one-tenth of a millionth of nitrous acid per c.c., are decolorized in a few minutes after being gently heated. A strong and prolonged heat is to be avoided. Attempts made at the titration of nitrous acid by means of the blue molybdic solution have so far given unsatisfactory results. Still if we admit that 1 mol. of permanganic acid corresponds to 5 mols. of molybdic oxide, it is easy to determine with precision the quantity of molybdic oxide contained in a liquid by titration with permanganate. It might therefore be possible to determine nitrous acid in a satisfactory manner by causing the blue solution of molybdic acid to react for a certain time, the length of which must be experimentally determined, and then titrating back with permanganate. The blue solution is not very stable.

Detection of Molybdic Acid.—M. O. Maschke.—According to Schoenn traces of molybdic acid and its compounds may be discovered by the blue coloration produced on heating it with concentrated sulphuric acid in a porcelain capsule. This test is rendered exceedingly convenient and much more certain by the following modification: A little concentrated sulphuric acid is applied to a piece of platinum foil, bent so as to form a slight depression; upon the acid is placed a little of the substance in powder, and the foil is heated till vapors escape in abundance; it is then let cool and repeatedly moistened with the breath. When after cooling only minute blue spots are visible, the sulphuric acid after being breathed upon takes an intense blue coloration. On heating the platinum foil, the blue color vanishes, but reappears on cooling. It is completely decolorized if a considerable quantity of water is added.

On Chromic Phosphate.—Phosphoric acid in combination with chrome may be easily overlooked in following the method indicated in Will's tables, when chromic oxide and chromic phosphate are obtained simultaneously in solution in potassa. On boiling this solution to precipitate the chrome, the phosphate is entirely decomposed, and not a trace of phosphoric acid is precipitated with the oxide of chrome.—*Zeitschrift für Analyt. Chemie.*

Chemical Industry at the Exhibition of 1878.—M. Adolphe Kopp.—The branches discussed in the present issue are sulphur, bisulphide of carbon, sulphuric acid, and alkali. Little appears to have been done in the last few years toward improving the manufacture of sulphuric acid. M. de Hemptinne causes the sulphurous acid derived from the combustion of pyrites to pass through two concentric chambers, so that the impurities may be deposited. The top of the chambers is occupied by a vat in which the concentration and denitrification of the acid are effected. This vat is of sheet iron and it is lined with lead. Its bottom is traversed by 100 tubes of lead, 1 meter long and 50 centimeters in diameter. In each tube is suspended another more slender, the lower extremity of which is open almost like the steam tubes in Field's boiler. This second tube opens at 10 centimeters from the bottom, and serves to feed the former with weak acid. In this manner a constant current of acid is established in the tubes, and it is concentrated to 61° B. In order to denitrify it, the vat is covered, and by means of a leaden tube the sulphuric acid which has already entered the chamber is aspired; it is passed by a sort of Giffard's injector through the nitrous sulphuric acid and the watery vapors derived from the evaporation. The sulphurous acid loaded with nitrous vapors returns into the chambers by another tube. The lead chamber in which the transformation is to take place with extreme rapidity is lined with sheets of lead and filled with 5,200 earthen bottles fitted with holes. The nitric acid enters the chamber by means of a Welter's funnel, and weak sulphuric acid is thrown over the bottles at regular intervals. No steam enters the chamber, except the jet which is between the chimney and the Gay-Lussac towers. There is no information as to the practical value of this process. The drums and the cascade apparatus for denitrifying the acid, as described in the works of Knapp and Wagner, have not been generally introduced into manufactories. These systems differ from Glover's tower, inasmuch as water plays the part of denitrificator as the gases enter it saturated with moisture. Probably the great waste of lead has caused these contrivances to be rejected; in fact, the weak sulphuric acid which runs down the sides is saturated with weak sulphurous acid, and is of course highly destructive to lead. The drums have been replaced by large stoneware bottles, similar to those employed for the condensation of hydrochloric acid, and filled with fragments of coke. In these denitrification is well effected, vapor of water being used, not sulphurous acid. The acid is concentrated to 48° B. Latterly various interesting communications have been published concerning Glover's tower, and this apparatus, which in 1873 was only known for concentrating the acid, seems to become more generally used, not merely for this purpose but also for denitrification. On this point a brisk controversy has sprung up in the English and German journals. M. Kuhlmann having studied the action of sulphurous acid upon the binoxide of nitrogen and hyponitric acid, proved that the oxides of nitrogen are to a great extent reduced to protoxide. MM. Pelouze, Fremy, and Weber have arrived at the same conclusions. In presence of water the reaction goes still further. M. Vorster has come to the same results, and applying his laboratory experiments to the reactions which take place in Glover's tower, he argues that though the process of denitrification is complete in this apparatus, it is carried too far, nitrous oxide and even free nitrogen being formed with a loss of 40 to 70 per cent. Thus in England alone the loss would be equal to 3,600 tons nitrate of soda annually. On the other hand, Dr. Lunge considers that the English manufacturers could not but have become aware of the loss attending the new process, had such really existed. But no greater quantity of niter is decomposed than by the old process—2·14 per cent of the sulphur employed, or if without a Gay-Lussac's tower 3 per cent. He further explains the differences which have arisen between theory and practice. It has been certainly proved that nitric oxide is easily reduced by sulphurous acid to nitrous oxide and even to nitrogen, nitrous acid less readily, and nitric acid less readily of all, but only under conditions which do not occur in practice. The experimentalists above mentioned have, *e. g.*, caused the gases to react upon each other in a state of purity, while in Glover's tower the sulphurous acid is mixed with a large excess of air. The process of denitrification is chiefly effected in the upper part of the tower, where the gases are coolest, the temperature of the acid being never above 120°–140°. There are nevertheless two cases where Glover's tower cannot be used. If the nitrous sulphuric acid coming from the Gay-Lussac towers is contaminated with impurities extracted from the coke, the temperature of the Glover's towers is not elevated enough to burn these organic particles; the acid remains brown, and this coloration disappears but slowly, until the coke has been used for several months. The Gay-Lussac towers might indeed be filled with some other substance, but such is not easy to find, on account of the low price of coke, its porosity, and its resistance to acids. If the pyrites used contain much ash, the result will be an impure acid containing much iron. The author describes next the improvements in apparatus for the concentration of chamber acid, speaking very highly of that devised by Messrs. Johnson and Matthey, of Hatton Garden, and now on view in the English section of the Exhibition. The methods proposed for the removal of arsenic present in sulphuric acid are not pronounced perfectly satisfactory, the best being that of Dupasquier, who adds barium sulphide and hyposulphite.

Use of Soluble Glass in Bleaching Cotton.—M. R. Meyer spreads out the cotton to be bleached, without moistening it previously, in a chest fitted with squeezers, containing a solution of silicate of soda, and placed in an iron cylinder, open above, and fitted with a double bottom. The solution consists of 1 liter silicate of soda at 20° B., and 120 liters of water. When the cotton is saturated with this liquid it is further covered with a similar quantity of the same solution, and boiled for two hours. The liquid is drawn off strongly colored, and is replaced by boiling water, which is kept in ebullition for an hour. This operation is repeated once more, when the bleaching is complete, and the cotton is drained and washed. The first washings should be made with boiling water, for, if cold or lukewarm water is employed, the dirt is re-precipitated upon the cotton. For the same reason it is proper to pass the cotton through a centrifugal machine before washing.

Violet Ultramarine.—M. J. Zellner.—The inventor claims the four following processes: 1. He passes a dry halogen, preferably chlorine, over blue or green ultramarine heated to

300°, and obtains the halogenic derivatives of ultramarine. 2. He heats blue or green ultramarine to 160° to 180°, passing into it chlorine (or some other halogen) along with the vapor of water. There is formed what the author terms hydroxylized violet ultramarine, along with chloride of sodium, which is eliminated by washing; 34 kilos. of chlorine are required for 100 kilos. of ultramarine. 3. Blue or green ultramarine is heated with a mixture of such salts as ammonium nitrate or chloride, or with any mixture giving off watery vapor and a halogen on the application of heat. There is formed violet hydroxylized ultramarine or, in presence of ammoniacal salts, "amidic ultramarine." 4. The conversion of ultramarine into violet ultramarine may be likewise effected more or less completely by submitting blue or green ultramarine at 160° or 180° to the action of an acid, an oxidizer, of water, or a mixture furnishing these three bodies.—*Muster-Zeitung.*

Falsification of Logwood.—Formerly this extract was adulterated with indifferent substances, so that the value of a sample could be ascertained by simply dyeing a swatch. Now the extract is sophisticated with coloring matter of less value, such as sumac, chestnut wood, gall nuts, etc. [There is a mistake here: the cheapest gall nuts cost twice the price of the dearest logwood.—*Ed. Chem. News.*] The following method may be recommended for detecting this new fraud: Exhaust 1 decigramme of the sample dried at 110° in the gramme of absolute ether, and weigh the residue after evaporation of the ethereal extract; treat the portion left undissolved by ether with alcohol, and compare the weights of these two extracts with those given by a normal extract of logwood. The extract of chestnut wood being insoluble in ether, but soluble in alcohol, it is evident that a sophisticated extract will contain a larger proportion of matter insoluble in alcohol than a genuine sample. It may also be useful to make quantitative dyeing experiments with the portions respectively soluble in alcohol and ether.—*Journal de Fabricants de Papier.*

Manufacture and Use of Chlorophyl.—MM. Secourt and Guillemare take the leaves of spinach, nettles, etc., and macerate them in water. The whole is then boiled with an equal weight of soda-lye at 12·5° Baumé, and the liquid thus obtained is precipitated with alum. The lake thus yielded is washed and pressed, and is then mixed with an equal weight of a soluble phosphate, an alkaline citrate, or a bitartrate, and then diluted with water down to 2° to 5° Baumé. This solution retains its color and may be advantageously used for giving a green to preserved vegetables, etc.—*Chemisches Industrie-Blatt.*

Nitro-Alizarin.—M. Caro has patented several processes for the preparation of the alizarin-orange resulting from the action of nitric acid upon alizarin. The alizarin is spread out in a thin layer upon the floor of closed chambers, and is submitted to the action of vapors of nitric acid. Another method is to dissolve the alizarin in ether, glacial acetic acid, petroleum, or nitro-benzol, and to pass a current of nitrous acid through the solution; 20 parts of the solvent are employed to 1 part of alizarin, and the current of nitrous acid is kept up until it ceases to be absorbed. The coloring matter is collected either by distilling off the solvent or by precipitation with an aqueous solution of potassa and subsequent precipitation of the salt formed with an acid. When glacial acetic acid is used as a solvent, nitric acid of sp. gr. 1·38 must be added. Sulphuric acid of sp. gr. 1·840 may likewise be used as a solvent.

Suppression of Dysentery.—Dr. Dounon.—From observations made in Cochin China, it appears that dysentery is due to certain animalcula, *Anguillula stercoralis* and *dysenterica*, *Ankylostoma dysenterica*, etc., introduced into the intestinal canal by means of polluted waters. The disease may be obviated by never partaking of water unless it has been previously purified by alum, or, better still, by boiling. The treatment with alum has been successfully used by the natives of Annam from time immemorial, and during six years has completely preserved the French troops in Cochin China from this dreadful scourge.

Black in Dyeing.—M. Moyret.—The author maintains that there is no true black in dyeing, the so-called blacks being merely dark colors. Nevertheless, the dyers of the Gobelins, when they declare that blue is a light black, are wrong as far as the colors of the present day are concerned.

Dry Bromide of Silver Emulsion.—M. Chardon.—The author is declared to have succeeded in producing a simple and certain dry photographic process admirably adapted for use during scientific expeditions in barbarous countries. The so-called dry emulsion is a compound of collodion, containing in its pores a suitable quantity of the bromide of silver. This substance, if placed in bottles and preserved from exposure to the light, retains its properties for an indefinite time, even at very elevated temperatures. When it is required to employ the emulsion, about four grms. are dissolved in 100 c.c. of a mixture of equal parts of ether and of absolute alcohol; after agitation and twenty-four hours' contact the liquid is filtered and the plates are covered and then dried without any further preparation. When dry they are fit for use, and retain their properties for some months. The development of the impression may be effected either forthwith or a long time afterward. Thus proofs taken at Aden have been developed at Paris.

Tin Foil for Chocolate Manufactories.—MM. Charles Kopp and G. Engel.—In these tin foils lead was found in mere traces as compared with the so-called tin which is brought in contact with articles of food in England in the shape of tinned iron. One sample, however, contained antimony to the extent of 6·111 per cent. along with 0·889 per cent. of arsenic.

Crude Tartars.—M. A. Scheurer-Kestner.—The tartaric acid in tartars is present as bitartrate of potassa and neutral tartrate of lime, the former of which is the principal constituent. It is generally determined by means of a standard solution of soda or potassa. Sometimes, instead, the product derived from the calcination of the tartar is titrated. Ignition transforms the titrate into carbonate, but in this case there is danger of titrating simultaneously the carbonate of lime, and of thus committing an error if it is not rectified by a special determination of the tartrate of lime. But if the tartar contains calcium sulphate, its value may be lowered by the action of the potassium carbonate upon the plaster. If the tartars are free from calcareous salts, the titration of the ignited residue gives results perfectly exact. It is not always the same with the direct titration of the acidity by means of a standard alkali. Certain tartars, and especially certain dregs of wines, contain acid organic products distinct from tartaric acid. The calcium tartrate yielding a double quantity of alkaline substance for the same proportion of tartaric acid compared with that yielded by the cream of tartar, it would be a grave error to titrate the entire product of calcination with standard acid. In this case it is proper to treat the ignited product with water till all the soluble salts are dissolved, and to titrate the solution thus obtained. This method leaves nothing to be wished if the tartar is free from plaster; in the contrary case there are formed during the solution potassium sulphate and calcium carbonate. If tartars contain plaster, it is almost impossible to determine with accuracy the relative quantities of potassium bitartrate and calcium tartrate. It is practicable only in the absence of organic acids other than tartaric. In this case the bitartrate may be determined by the use of a standard alkaline liquid; the whole of the tartaric acid in the sample may then be determined as calcium tartrate, and the original proportion of the two salts may be found by calculation. Exact and concordant results may be obtained by the following process: The sample in question is dissolved in hydrochloric acid. The solution is filtered, mixed with calcium chloride and precipitated by caustic soda, but to avoid the possible precipitation of calcium hydrate the saturation is completed with ammonia. Instead of caustic soda ammonia may also be used for the precipitation of calcium tartrate, but in this case the quantity of hydrochloric acid employed must be limited, calcium tartrate being slightly soluble in ammonium hydrochlorate. The precipitate obtained is collected on a filter, washed, ignited, and determined by means of standard solutions.

Annatto.—According to M. C. Etti, there exists in annatto a third tinctorial principle, a soft, brownish-red coloring matter, which has not yet been examined.

"Gum-Ammoniac."—The gum-resin obtained from Morocco under this name, if heated in contact with potassa, yields resorcin, and a small quantity of an acid precipitable by plumbic acetate, and taking a red color in contact with iron. Its composition is given as $C_{16}H_{16}O_5$, isomeric with hemipinic acid. The substances met with in commerce under the name of "gum-ammoniac" differ respectively in their chemical properties.—*Dr. Goldschmidt.*

Distinction of Colors by Artificial Light.—The light of Swedish safety matches is sufficiently white for recognizing the difference between greens and pale blues.

Cleansing Glass Vessels.—For quickly and perfectly cleansing glass vessels, especially if soiled with fatty matters, Walz recommends the application of a concentrated solution of potassium permanganate, mixed with a few drops of hydrochloric acid.

Detection of Alcohol in Methylic Spirit (Wood Naphtha).—The liquid to be tested is distilled with sulphuric acid, the distillate mixed with potassium permanganate and sulphuric acid, any turbidity being removed by means of sodium hyposulphite, and a very dilute solution of magenta is added drop by drop. If alcohol was present, the red color of the magenta is changed to a violet, by the acetaldehyd which is formed.—*Zeitschrift f. Anal. Chemie.*

Separation of Nickel and Iron.—The process depends on the insolubility of ferric phosphate in acetic acid, in presence of sodium phosphate in excess, while nickelous phosphate is soluble. The hot solution of the two metals containing free acetic acid is mixed with sodium phosphate, the ferric precipitate is removed by filtration; from the filtrate phosphate of nickel is thrown down by the addition of potassa, the precipitate is dissolved in sulphuric acid, the solution is rendered alkaline, and the nickel precipitated by the galvanic current. The process is only applicable where the nickel does not exceed 3 per cent.—*Zeitschrift f. Anal. Chemie.*

AN ALLOTROPIC CONDITION OF COPPER.

SCHÜTZENBERGER by the electrolysis of the salts of copper has succeeded in preparing this metal in a form which, from its physical and chemical properties, is found to be a distinct allotropic modification of the metal. He obtains it by using a 10 per cent. solution of the acetate, which has been boiled for a few minutes to remove the free acid, and decomposing it with three Daniell or two Bunsen cells. The negative platinum plate is of somewhat smaller dimensions than the positive copper plate and is placed at 3 or 4 centimeters from it. The side of the platinum plate which faces the copper electrode becomes covered with the metal in the allotropic condition; the other side is covered with a thinner layer of ordinary copper. The new form of the metal is not so red as usual, and resembles some bronzes in color; it is brittle, and so far from being malleable may, like sulphur, be reduced to powder in a mortar. Its specific gravity is from 8·0 to 8·2, that of ordinary copper being 6·9. It easily oxidizes in moist air, soon becoming iridescent, and eventually becoming coated with an indigo-blue layer. When treated at ordinary temperatures with a mixture of one part strong nitric acid and ten of water, the metal if at all oxidized is at once attacked, nitrous oxide being evolved and the metallic surface assuming a dark olive-black hue. Ordinary copper resists the action of this dilute acid, while concentrated acid does not turn this form of the metal black, and causes the evolution of nitric oxide. The allotropic modification is converted into ordinary copper by the action of heat, or by prolonged contact with dilute sulphuric acid. The author found that the new substance was not a hydride and that its physical and chemical characters were not due to occluded hydrogen; it appears to be an actual allotropic modification of the metal which, when converted into ordinary copper, evolves heat.

THE ARTIFICIAL PRODUCTION OF INDIGO.

THE first instance in which the chemist had ever succeeded in artificially preparing colors occurring in the vegetable kingdom happened in 1868, when Profs. Graebe and Liebermann of Germany produced from the coal-tar product anthracene, the brilliant dyestuffs that had hitherto been derived solely from madder. Although the manufacture of these artificial madder colors has assumed such proportions that it bids fair to supplant entirely their manufacture from the plant itself, it has up to within a few weeks remained the only instance of the kind in the history of chemistry. But now we are able to announce the successful production, by synthesis, of another important vegetable dyestuff, this being none other than common indigo. This discovery is due to Prof. A. Baeyer, the successor of Liebig to the Chair of Chemistry at Munich. For many years this brilliant chemist has been working indefatigably to solve the problem of the constitution of indigo and its synthetical preparation, slowly and patiently gathering together and elaborating fact after fact. Finally, at the last session of the German Chemical Society he announced the completion of his long and arduous researches, and the discovery of the last link in the chain of synthetic reactions leading to the formation of indigo. This may be considered, very justly, one of the most brilliant chemical triumphs of the present year.

From the products of the decomposition of indigo-blue, or indigotine, such as aniline orthoamidobenzoic acid, etc., it has long been regarded as closely allied to the benzine series. A great number of attempts have been made to show the nature of this connection by starting from benzine compounds, but hitherto without success. The first step in the present solution of the problem was to carefully study the various compounds resulting from successive decompositions, each yielding in turn a body of simpler composition. Passing from one compound to another Prof. Baeyer finally reached Alpha toluic acid, a not uncommon body, easily prepared from cyanide of benzyl. Here he stopped and retraced his steps. From this point it would be difficult to follow him in his successive operations without the use of chemical symbols, which would interest the professional chemist only. It is only necessary to say that, at length, having obtained *isatin* (a substance resulting from the oxidation of indigo), and eliminated two atoms of its oxygen, the transformation was complete.

The number and costliness of the operations that are necessary in this process will probably, for the present, prevent a practical utilization of the ingenious succession of reactions by which Prof. Baeyer reached his results, yet they present us with a remarkable example of the possibilities of the organic chemist of the present day.

THE PRODUCTS OF COMBUSTION.*

By THOMAS WILLS, F. C. S.

WHEN certain bodies are brought into very close proximity to each other, a combination, or a separation, or a rearrangement of their constituents takes place. Such an action is called a chemical action; and under whatever circumstances such a chemical action takes place, an invariable result is observed—namely, a development of heat.

HEAT A MODE OF MOTION.

Such heat is conceived to be due to the rapid motion of the molecules of which the bodies consist. The intensity of this heat varies; but when the motion is sufficiently rapid to give rise to the manifestation of light, combustion is said to occur. Now, the amount of heat which can be generated in any chemical action is fixed and definite, and it may be regarded, so to speak, as a potential property of the substance or substances which are undergoing change. It belongs to the matter in which the change is proceeding. But although this heat is an invariable quantity, and its amount cannot be altered by us under any circumstances whatever, the temperature obtained is not at all uniform; that is to say, the temperature manifested in any given chemical action, or even in the same action under different circumstances, is by no means uniform. It is always an expression of the heat evolved, but it is itself variable, and is governed by circumstances. Let me endeavor to make this point clear by illustration.

If I take a piece of iron, and permit it to rust in moist air, a certain definite amount of heat is evolved by the chemical action which is going on between the iron and the oxygen of the air. The amount of this heat is dependent entirely on the amount of the iron and the amount of the oxygen which take part in the action. But if I take such a piece of iron as this [an iron bar], and expose it to moist air, probably there would be no appreciable rise of temperature; I could not, even by the most delicate thermometer, recognize the amount of heat evolved in such a chemical process. But if I took the same weight of iron, and caused it to oxidize in the air under other circumstances, I might so develop the heat evolved in a short time, and in a small space, as to manifest itself, not only by means of a delicate thermometer, but in the visible shape of light.

SPONTANEOUS COMBUSTION OF IRON.

In this tube I have a quantity of metallic iron in a very fine state of division. The tube is sealed at both ends, and the iron is, therefore, out of contact with air. I shall break the tube, empty the contents on to this paper, and I think you will see by the incandescence which occurs with this iron, and possibly the inflammation of this piece of paper, that heat is evolved in this process of oxidizing iron, and the process is identical in every respect with the one which goes on when I oxidize a piece of iron in moist air. [The experiment was performed.] You see here we have the iron made red hot, and the paper itself takes fire. That is only an illustration of what I was saying a moment ago, that the temperature may vary, although the quantity of heat would be the same. If the weight of iron which I had in the tube had been exposed to the air in the massive state, until the metal had been converted into oxide of iron, precisely the same amount of heat would have been obtained as in this case; but the light, or manifestation to us of heat in that action, is much greater in this case than in the other. A familiar example of this occurs to me. If we take a piece of wood—say a branch of a tree—and it is allowed to remain lying on the ground in the forest, it gradually decays. It may take weeks, or months, or possibly years, to decay and pass away into other combinations. If, however, we thrust it into a fire, it burns, giving out heat and light; but the amount of heat in each of those cases will be precisely the same for a given weight of wood.

NATURE AND DEGREE OF CHEMICAL ACTION.

The term "combustion" is usually restricted to those cases in which burning takes place with flame—in other words, those cases in which the burning bodies are in the gaseous condition. All flames are gaseous flames, and, whenever we have combustion taking place with inflammation, we are dealing with gaseous substances. Now, passing on a step further, and tracing the phenomena upward, the temperature we can set up in a particular chemical action is an important point. Chemical actions are found to become more and more active as the temperature rises. Two bodies, which act upon each other slowly at ordinary temperatures, if heated up to a higher temperature before being brought into contact, will act upon each other much more energetically. Conversely, if we reduce the temperature of the substances which act upon each other, the activity of the chemical action is reduced in the same way, and it is probable that if we could obtain an infinitely low temperature no chemical action whatever would take place—that is to say, all chemical action might be prevented by lowering down to a sufficiently low extent the temperature of those bodies which would act on each other.

SPONTANEOUS COMBUSTION OF ZINC-ETHYL.

Now, if when a chemical action is once set up the motion of the molecules, or the intensity of the action, be sufficient to produce the phenomena of light, then combustion is said

* A recent lecture delivered before the British Association of Gas Managers.

to take place. But this is a temperature which differs for different substances. All bodies do not take fire and burn at the same temperature. All bodies will not enter into combination with each other at the same starting-point. To illustrate this, I have here in this tube a substance which is a compound of the elements zinc, hydrogen, and carbon. It is called zinc-ethyl. This body is sealed up in a small glass bulb, out of contact with air. If it comes into contact with air, chemical action is immediately set up between the liquid and the air. At ordinary temperatures this body is said to be spontaneously inflammable. In other words, when it comes into contact with air, the chemical action is sufficiently intense to immediately raise the temperature up to the point at which light is manifested. If I break this bulb, as I do now, I think you will see that the substance will itself spontaneously inflame. It takes fire and burns the moment it comes in contact with the air, so that the initial temperature of chemical action, or of combustion in this case, must at any rate be lower than the temperature which we have round about us at the present time.

PHOSPHORUS SET ON FIRE BY WATER.

Now we go a step further, taking another substance with which we are familiar—the elementary substance known as phosphorus. If I take a small piece of phosphorus and place it on this plate, the phosphorus, unlike the body I have just used, does not take fire and burn by itself; but I can show you that the temperature at which it will take fire and energetically enter into combination with the oxygen of the air is a very low one—lower, in fact, than that of boiling water. If I take a tube containing a little water, and simply raise the water to the boiling point, and then touch the piece of phosphorus with the tube containing hot water, you will see the phosphorus itself will immediately take fire and burn in the air. I transfer the hot water to a cold tube, so that there may be no excess of heat in the tube itself, and on touching the phosphorus with it, it immediately takes fire and burns. So that we have here a substance which we can cause to enter actively into combination with the air at an initial temperature higher than that of the previous substance.

COMBUSTION OF BISULPHIDE OF CARBON.

I now pass on to another. I take a few drops of a liquid well known, I expect, to every one present—bisulphide of carbon. If I take hot water and put the tube containing it in contact with the bisulphide of carbon, you will see it is unable to set the vapor or liquid of that substance alight. If, however, I take a temperature slightly higher than boiling water—such as I can get by heating this glass rod in the flame—I shall succeed in lighting the bisulphide. You see the tube with boiling water in it fails to set it on fire; evidently, therefore, it requires a higher temperature for its ignition than phosphorus. Now, I heat the glass rod to a point not very much in excess of the temperature of boiling water, and when I bring that in contact with the bisulphide it takes fire at once. This rod is far below the temperature of redness, but it is higher than boiling water. Here again we have a difference in the initial point at which combustion takes place.

INFLAMMABILITY OF COAL GAS.

I might go on and take coal gas. If I take a hot wire I can ignite coal gas by means of the wire. I cannot ignite a candle at the same temperature at which I can ignite the coal gas. So I might go on and perform a whole series of experiments in which we should require a different temperature in each case.

WHEN COMBUSTION ENSUES.

Now, if at this temperature, which we may call the initial temperature of chemical action, a body enters into active union with a second body, with intensity enough to produce the phenomena of light, we have all the ordinary effects of combustion.

EXAMPLE OF SLOW COMBUSTION.

It is possible, however, to get a kind of combustion in which we have not arrived at the temperature at which the substance enters into the most active union with the supporter of combustion; in other words, we can have an imperfect combustion, and I shall show you two illustrations of this. I have here a burner through which coal gas is streaming. If I take a piece of platinum foil, just warm it and bring it over the gas, the platinum foil gets red hot, and keeps red hot, but it does not inflame the gas. The gas is streaming round it, but it is not inflamed. The temperature of the platinum is not high enough to inflame the gas, but it is high enough to keep up a slow imperfect combustion. If I raise the temperature of the platinum a little higher, the gas will take fire. I think I can do that by raising the platinum foil slightly higher. It will then get hotter, and the gas will be inflamed.

CURIOUS DIFFERENCES RESULTING FROM THE MANNER OF FIRING GUN-COTTON

In concluding this point, I have one more interesting effect to show you, which can be illustrated very well by some gun-cotton, which has been twisted into yarn in the form in which it is sometimes used in Austria. I take two pieces of the same length, and lay them side by side upon this board. I ignite one in the ordinary way with a flame, and I want you to observe the manner in which the gun-cotton, lit by a flame, burns. It takes fire and burns with a flame very rapidly down its whole length, giving out light. Now I will light the other one with a spark, which is considerably lower in its temperature than a flame, and you will see a considerable difference—this piece of gun-cotton, of precisely the same composition, cannot burn in the same way when it is simply set fire to by a spark instead of a flame. I can prove to you it is really a question of temperature in the following way. If I take a piece of this gun-cotton, as we had it in the latter case, burning with a slow fuse-like rapidity down its whole length, and hold it up while so burning, the heat, which is generated at its end, accumulates round the gun-cotton about to be consumed; the temperature, therefore, is slightly higher, and it will elevate itself to that point at which it enters into combustion with flame. Taking the spark and setting fire to the gun-cotton as before, it burns slowly. Then when I hold it up vertically, in a moment the temperature is raised sufficiently for it to burn with flame.

COMBUSTIBLES AND NON-COMBUSTIBLES.

Now, the possibility of setting fire to many substances, and the apparent impossibility of setting fire to others, has led to a division of bodies into two classes—combustible and non-combustible; but such terms are purely arbitrary, and refer only to ordinary circumstances. Many bodies which do not ordinarily burn may be made to do so if we only raise their temperature to a sufficient point, if we only obtain and maintain an initial temperature of sufficient intensity. A piece of wood we understand as a combustible body; a piece of sulphur, in like manner, we recognize as a combustible body, because we can set fire to it.

BURNING OF IRON.

A piece of iron, on the other hand, we do not usually regard as a combustible substance. Our fire-grates and pokers are usually made of iron, and we do not regard those materials as being combustible. At the same time they are so in reality if we only have a temperature sufficiently high. I will show you that this is the case with iron by an experiment. I am going to use a temperature which is simply higher than that ordinarily obtained in our grates, or even in the hottest wind furnace—the oxyhydrogen blowpipe. I have here a quantity of iron nails, and these I am going to endeavor to burn as we ordinarily burn combustibles, and I think you will see they will burn well, with a considerable amount of brilliancy.

TEMPERATURE PRODUCED BY THE BLOWPIPE.

This blowpipe is simply an apparatus whereby I can drive into a current of coal gas a current of oxygen; and in that way shall raise the temperature of the flame up to about 2500° C. At this temperature we obtain the combustion of these iron nails. A great part of the flame is due to the combination of the iron with the oxygen.

It is evident, therefore, that the terms "combustible" and "supporters of combustion" are arbitrary only. Still, however, when all is said and done, we do arrive at a division of bodies into these two classes, for there are some bodies that we cannot make burn, and there are other bodies which, at a high temperature like this, we can make to burn.

For instance, a piece of pumice is really an incombustible substance; there is no temperature at which we can make that substance enter into combination with the oxygen of the air and burn, so we simply widen our definition. We remove from it its arbitrary character, and make it general, when we deal with bodies like pumice, for example.

THE OLD THEORY OF COMBUSTION.

Familiar as men have always been with the phenomena of combustion, a true conception of its nature has only been arrived at within a very modern date, and by careful observation and experiment. Up to the latter part of the 18th century, what was known as the phlogistic theory of combustion, which took its rise 100 years earlier, was regarded as a sufficient explanation of the phenomena which were seen to occur. This theory, like many other erroneous theories which have held sway in the minds of men for a long period, died a very hard death. Generally speaking, the theory was this: The philosophers of that date believed that a combustible substance was made up of a material body, which they termed phlogiston, and of a second material substance which was left behind after the combustion had taken place. For example, they saw that wood burned, leaving a very small quantity of ash, and they said the wood had in burning lost the phlogiston, and the ash was left. The wood originally consisted of a compound of phlogiston with this ash. They saw again when a piece of metal was exposed to the air it was rusted, or when it was put into the fire it burned and left behind a kind of earth or calx, and they explained the fact by saying that the metal originally consisted of phlogiston, which it had lost during the process, and this calx or earth which it left behind. Now, much of this imperfect theory arose from the want of knowledge of the nature of air, and of the part which air takes in the support of all our ordinary combustions.

THE PRESENT THEORY OF COMBUSTION.

They did not recognize the interdependence which exists between what we call combustibles and what we call supporters of combustion; and consequently, as soon as this was demonstrated by Lavoisier, then the phlogistic theory was doomed, the old philosophy was upset, and a newer and better, because a more true one, took its place. The principles upon which we now explain ordinary combustion at the present day are briefly these—that, first, in any chemical action, whether accompanied by the evolution of light or not, the sum of the weights of the bodies taking part in that action remains unaltered.

NO LOSSES OF WEIGHT BY COMBUSTION.

This is so important a matter that, with your permission, I shall illustrate it; for, although we acknowledge these facts constantly; sometimes if they are brought before us in the shape of a lucid experiment the matter is thereby clinched in our memory, and we are no longer in any manner of doubt about it. Here I have a common oil flask which is capable of being closed with a sound tightly-fitting cork. I introduce into it a small piece of phosphorus. Phosphorus is kept under the surface of water on account of its inflammability. Therefore I dry it first in folds of blotting-paper; then I introduce it into the flask, and put the cork in as tightly as I dare without cracking the neck of the glass. Now I place this phosphorus and glass on a balance, which I bring into equilibrium. Taking the flask away and setting fire to the piece of phosphorus, it burns. There is an intense chemical action going on, the phosphorus burns within the flask, and finally it will go out. When it has got cool I shall replace it on the balance, and I want you to observe that there has been no change whatever in the weight. It will now weigh precisely what it did before, showing that there has been no loss or gain in the weight. Therefore, in any chemical action, if we take into account the weight of the combustible and the body supporting combustion, it will be always the same amount. If I try it before it is quite cold, it will weigh lighter, but on allowing it to cool, and putting it into the balance, I think you will find if the cork is tight the equilibrium has not been destroyed. This is an exceedingly important experiment, and it is one of the kind which determined the abolition of the phlogistic theory.

TWO OR MORE SUBSTANCES NECESSARY TO CHEMICAL ACTION OR COMBUSTION.

The second point is that the combustion is the evidence of a chemical action taking place between two or more bodies, the presence of each of which is necessary. The combustion of a piece of wood, for example, does not depend on the wood alone, but also upon something which can act upon the wood, and with which the wood can combine. In any case, we must have two or more substances before we get any chemical action or any combustion. The chemical action depends upon something besides the mere combustible, as may be shown by an experiment which has been constantly made, and which can be made at any moment one wishes. If I take a candle and cover it with a jar, you will see in a very short time that the candle goes out. Why? Not because there is no candle there; there is plenty of combustible matter, but the second substance, the oxygen of the air, which is necessary to the support of that candle flame, has been exhausted. Therefore, the process of combustion is an interdependent process, and depends as much on the supporter of combustion as on the combustible itself. In fact, our combustibles and supporters of combustion of to-day are, so to speak, simply accidental ones.

The process of combustion goes on simply at the limit, the line of demarkation, where the two bodies which act upon each other come into contact, and it depends upon which of them is in excess, which of them for the time being becomes the supporter of combustion, or is the combustible itself. If we have air in excess, then air becomes our supporter of combustion. If, on the other hand, we had an atmosphere of coal gas, the bodies which we now call combustible would cease to burn in it, and we should have to look to those bodies which at the present time we call supporters of combustion in order to get any illumination at all.

RELATIONSHIP BETWEEN SUPPORTERS OF COMBUSTION AND COMBUSTIBLES.

Now, I can show this relationship between supporters of combustion and combustibles themselves in two or three ways. I take here, first of all, a jet of hydrogen gas burning at the end of this tube. I introduce this into a bottle which contains oxygen gas. The hydrogen continues to burn, and burns with rather increased brilliancy, in the bottle of oxygen gas. It is an ordinary case of a combustible and supporter of combustion.

Now I propose to reverse the matter entirely, and to burn a jet of oxygen in an atmosphere of hydrogen. Here I have a vessel of hydrogen gas, and coming through this tube I have a jet of oxygen. The oxygen gas will not burn, as I can show you, by holding a light to it; it causes the taper to burn more brilliantly, but I cannot set fire to the gas itself. Here, then, in this hydrogen I have a substance which a moment ago was burning itself. If I take it and set a light to the gas, and introduce the oxygen jet into the atmosphere of hydrogen, the oxygen burns with a considerable amount of brilliancy. We have, therefore, simply reversed our usual process.

Why has this been the case? Because we have, in the first case, a large excess of oxygen and a small quantity of hydrogen, and in the latter case a large quantity of hydrogen and a small quantity of oxygen.

INFLAMMABILITY OF COMMON AIR.

All our ordinary gas flames burn, as you are aware, in air; but we can, if we simply make a suitable arrangement, cause air to burn in an atmosphere of coal gas. Here is an apparatus arranged for this purpose. Into the base of this glass vessel some coal gas is conducted. Through the center of the cork there passes a tube, which is in free communication with the external air. I can put up through the cork this taper. Through the glass tube I am conveying coal gas, and in the ordinary way I can set fire to the coal gas at the top, where it burns. But we have now going in through the open tube a little jet of air, and I can set fire to that air within the atmosphere of coal gas. I have simply surrounded the flame of air with a coil of platinum wire, in order that it may be more obvious at a distance. The flame burns with a non-luminous flame, very much like a Bunsen burner, but by surrounding it with a small coil of platinum wire you can see the heat produced by the flame.

GAIN IN WEIGHT BY COMBUSTION.

First we have, then, the non-alteration of weight; secondly, the relation between the combustible and the supporter of combustion; and, thirdly, we find that the weight of the products formed is greater—rather, I should say, the weight of the products which are formed is a larger one than the weight of the original substance which is burning. If we burn a pound of candles, and weigh the products which are obtained, we get an increase of weight. We do not ordinarily see this. The candles disappear, oil, coal, and coal gas disappear; but it is because we have not arranged the circumstances in such a way that we can see the fact. An experiment will be fitted up with this balance, in which you shall see that such is the case. A flame of a candle is made to burn in this vessel. The products of combustion are passed through this tube and through the little globe which you see filled with fragments of a white substance, and finally up through the glass chimney. The white substance is placed here with a view to retaining and absorbing the products of the combustion of the flame which we have here. If we hang this on the balance, I think you will find that, although the combustible gets less and less in volume, and, consequently, in weight, that the whole apparatus gets heavier and heavier, because the combustible, *plus* the body which unites with it, is of greater weight than the combustible alone. We will first make the weight-pan slightly heavier, and you will see, long before the lecture is concluded, that the balance will have turned.

PRODUCTS OF COMBUSTION.

The nature of the products which we obtain from combustion varies. They may be either solid, liquid, or gaseous; and I have now, in going on with my story, to call your attention to the composition of the substances which we usually utilize for illuminating purposes, because it will depend upon the composition of these bodies what is the nature of the product or products which we obtain. These bodies consist essentially, all of them, without exception—all ordinary bodies used for illuminating purposes in which chemical action occurs—of compounds of carbon and hydrogen. A few of them, and only a few of them, contain oxygen, and the presence of other elements is rare, and may be regarded, so far as our present purpose is concerned, as accidental. Atmospheric air is the universal supporter of combustion for all ordinary processes of this nature; the air which we have to breathe, which exists as a mantle around the whole globe, forms the supporter of combustion for all such bodies. We should, therefore, expect that the products of any ordinary combustion would be compounds formed between the substances entering into the composition of the combustible matter and the constituents, either one or more, of atmospheric air.

COMPOSITION OF ATMOSPHERIC AIR.

I have here a table representing the composition of air, both by volume and by weight:

	Volume.	Weight.
Nitrogen	79·19	76·99
Oxygen	20·81	23·01
Total	100·00	100·00
Aqueous vapor (average)	1·40	0·87
Carbonic acid	0·04	0·06

Ammonia about one part per million.

(To be Continued.)